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THE PERFORMANCE OF SANTA GERTRUDIS CATTLE AND CROSSES IN THE PHILIPPINES [1]

LITO L. CALO, JOSEPH C. MADAMBA, GONZALO V. GARCIA, ERNESTO RIGOR, and BENEDICTO PARKER [2]

The blood picture, heat tolerance, and growth of the Santa Gertrudis and its crosses with the Philippine cattle and Philippine-Nellore grade were studied under pasture conditions. Results showed that the Santa Gertrudis and its crosses were markedly superior in size than the Philippine cattle and were not adversely affected by the warm tropical climate that we have in this country.

As a means for improving Philippine cattle, the Santa Gertrudis which is an exotic breed, is claimed to be very promising. It has been indicated that the superior beefing qualities, high tolerance to heat, and efficient calf crop of the breed are maintained under our climatic conditions and system of farming. However, before it becomes widely used by farmers in the country's improvement program, it is essential that further data be collected and analyzed on the performance of the Santa Gertrudis, including crosses with other breeds or strains of beef animals. Hence, this study was conducted from April, 1956 to March, 1959 at the Canlubang Sugar Estate.

The Canlubang Sugar Estate, which is a member of the Santa Gertrudis Breeders International, is situated about 11 kilometers west of Calamba, Laguna, at latitude 14°N and longitude 121°E. The total annual rainfall in the ranch ranged from 48.3 to 83.9 inches according to the records kept at the Estate from 1948 to 1959. The dry season is from December to April; the wet season, May to November. The pasture is dominantly Napier grass (*Pennisetum purpureum*) and African blue grass (*Digitaria pentzii*), each well mixed with Centrosema (*Centrosema pubescens*). Running creek water is freely available in all sections of the pasture area. About 300 heads of cattle are grazed rotationally on this 100 hectare improved pasture.

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[1] Central Experiment Station Contribution No. 2033. Project No. 958.

[2] Grateful acknowledgment is hereby expressed to Mr. Luis A. Yulo of Canlubang Sugar Estate whose wholehearted cooperation made this study possible; to Messrs. Calixto Digawan, Antonio Achacoso, Ildefonso Capinpin, and Jacinto Gallardo for their valuable assistance; and to Mr. Amador Yñiguez for his advice on the statistical treatment.

I. HEMATOLOGY

Review of literature. The blood picture has been suggested as a valuable guide in determining the adaptability of animals to changes in environment. Manresa *et al.* (1940) reported that high hemoglobin values are indicative of adaptability of animals to tropical conditions. The findings of Russoff *et al.* (1951) and Blincoe and Brody (1951) suggest that high hemoglobin and erythrocyte values are associated with adaptability to extremes of temperature.

Reporting on the normal ranges of the blood cellular elements in domestic and laboratory animals, Coffin (1945) stated that the blood of cattle has 8.0 to 14.5 grams of hemoglobin per 100 ml., 5.0 to 12.0 thousand leucocytes per ml., and 5.0 to 10.0 million erythrocytes per ml.

In the United States, McCay (1931) observed the hemoglobin indices of Holstein and Jersey cattle to be 10.6 ± 0.47 and 10.5 ± 0.32, respectively. Brooks and Hughes (1932) found the hemoglobin values of Holstein cattle to be 11.10 ± 0.081 and the Jersey cattle, 11.60 ± 0.203.

The results of similar studies on different breeds of cattle in the Philippines are given in table 1.

TABLE 1.—*Average hematological values for different breeds of cattle in the Philippines*

BREEDS	HEMOGLOBIN INDEX	ERYTHROCYTE COUNT	LEUCOCYTE COUNT	AUTHORS
	gm./100 ml.	*million/ml.*	*thousand/ml.*	
Brown Swiss	8.81	4.76	11.38	Lazaro, A. (1955)
Holstein	8.30	4.72	11.22	Cruz, dela (1956)[3]
Holstein	8.28			Manresa and Reyes (1934)
Hereford	6.76			—ditto—
Philippine	9.43			Manresa *et al.* (1940)
Nellore	9.87			—ditto—
Red Sindhi	10.05	7.92	7.29	Gajardo, R. (1954)[4]
Philippine-Hereford	8.9			Manresa and Reyes (1934)
Nellore-Philippine	9.7			—ditto—

[3] A. de la Cruz, "A further study of the leucocyte and erythrocyte counts and hemoglobin index of the blood of Holstein-Friesian cattle." (Thesis presented for graduation from the College of Agriculture, U.P., 1956. Unpublished.)

[4] R. Gajardo, "Hematological studies on cattle. The hemoglobin index, erythrocyte and leucocyte counts of the blood of the Red Sindhi and Holstein-Red Sindhi crossbred cattle." (Thesis presented for graduation from the College of Agriculture, U.P., 1954. Unpublished.)

Materials and methods. The study was conducted from September, 1956 to January, 1958. Five male calves were picked at random from each of the following herds of apparently healthy cattle: Philippine, Santa Gertrudis-Philippine, and pure Santa Gertrudis. All animals were unsexed except the pure Santa Gertrudis. On the average, the animals in each group were one year old at the start of the experiment.

The animals were kept entirely on pasture with the rest of the herd. On every first Monday of the month, they were segregated from the herd and confined in a corral for blood sample collections.

Five cubic centimeters of blood were drawn from the jugular veins into a test tube containing a drop of 30 per cent potassium oxalate as anti-coagulant. Leucocyte and hemoglobin indices were determined from the contents of one white diluting pipette using 0.1 N HCl solution as the diluting fluid. In erythrocyte enumeration, the same technique as in the leucocyte enumeration was used except that the red diluting pipette and Hayem's solution were employed. Hemoglobin indices were read with the use of a Haden-Hausser hemoglobinometer; the leucocytes and erythrocytes were counted with the aid of a microscope, a hemacytometer, and a tally counter.

Results and discussion. The average hemoglobin indices for the three groups of cattle are shown in table 2.

TABLE 2.—*Average hemoglobin indices of the Philippine, Santa Gertrudis-Philippine, and pure Santa Gertrudis cattle*

ANIMAL NO.	PHILIPPINE	SANTA GERTRUDIS-PHILIPPINE	PURE SANTA GERTRUDIS
		grams/100 ml.	
1	10.8	10.3	10.4
2	11.0	11.4	11.0
3	10.2	10.5	11.2
4	10.5	10.7	9.6
5	11.0	9.8	10.0
Mean	10.71	10.53	10.43

The mean hemoglobin indices of the five animals in each group during the observation period of 17 months are as follows: Philippine, 10.71; Santa Gertrudis-Philippine, 10.53; and pure Santa Ger-

trudis, 10.43 grams per 100 ml. of blood. Based on the range set by Coffin (1945), these indices are normal for cattle. No significant differences in the hemoglobin indices exist among the groups of cattle. The findings indicate that the Santa Gertrudis, including its crosses, is not impaired on exposure to hot climate. Temperate breeds like the Holsteins, Brown Swiss, and Herefords showed much lower hemoglobin values than the Santa Gertrudis cattle.

The average erythrocyte counts for the three groups of cattle are shown in table 3. The Philippine, Santa Gertrudis-Philippine, and pure Santa Gertrudis cattle had a means erythrocyte count of 6.08, 5.88, and 5.91 million per ml. of blood, respectively. These values are not only within the normal range for cattle but also much higher than those for temperate breeds (table 1).

TABLE 3.—*Average erythrocyte counts of the Philippine, Santa Gertrudis-Philippine, and pure Santa Gertrudis cattle*

ANIMAL NO.	PHILIPPINE	SANTA GERTRUDIS-PHILIPPINE	PURE SANTA GERTRUDIS
		millions/ml.	
1	5.72	5.66	5.92
2	6.36	7.18	6.42
3	5.87	5.38	6.27
4	6.22	6.10	5.13
5	6.22	5.05	5.18
Mean	6.08	5.88	5.91

The erythrocyte counts among the cattle groups and among determinations within groups do not show significant variations (table 3). This implies that the Santa Gertrudis and the Santa Gertrudis-Philippine crosses do not differ from Philippine cattle with regard to erythrocyte enumeration. As expected, however, erythrocyte counts of individuals within cattle groups varied markedly. The enumerations did not differ with months.

As shown in table 4, the mean leucocyte counts for Philippine, Santa Gertudis-Philippine, and pure Santa Gertrudis cattle are 8.49, 9.56, and 10.38 thousand per ml. of blood, respectively. It is of interest to note that the leucocyte count of the Santa Gertrudis-Philippine cross seems to lie midway between those of the parental stock.

The leucocyte counts amoung the cattle groups did not differ significantly (table 4). The enumeration between individuals within the groups, however, showed highly significant variations, as with the hemoglobin indices and erythrocyte counts. This is expected since in animals no two individuals are exactly alike.

TABLE 4.—*Average leucocyte counts of the Philippine, Santa Gertrudis-Philippine, and pure Santa Gertrudis cattle*

ANIMAL NO.	PHILIPPINE	SANTA GERTRUDIS-PHILIPPINE	PURE SANTA GERTRUDIS
		thousands/ml.	
1	7.06	8.42	14.14
2	9.17	11.27	8.98
3	7.72	11.54	9.21
4	8.36	7.41	9.44
5	10.19	8.87	10.09
Mean	8.49	9.56	10.38

Like the hemoglobin and erythrocyte values, the leucocyte enumeration obtained in this study falls within the normal range established by Coffin (1945). The Santa Gertrudis had a relatively lower leucocyte count than temperate breeds. This suggests that the Santa Gertrudis is less affected by tropical environment than other cattles of temperate breeds.

Conclusion. The Santa Gertrudis including its crosses is as resistant as Philippine cattle and even more than other imported breeds of temperate origin raised under local conditions. However, studies on other physiological characteristics associated with adaptability should be conducted to supplement these findings.

II. HEAT TOLERANCE

Review of literature. The Iberia Heat Tolerance Test as formulated by Rhoad (1944) has been widely employed to determine the ability of cattle to withstand hot environmental conditions.

Using this test, Manresa Jr. *et al.* (1955) reported that Santa Gertrudis cows have a heat tolerance index of 86 and the bulls, 88 with a mean respiration and pulse rates of 45.8 and 82.7 a minute, respectively.

Madamba *et al.* (1957) showed that on their second year of stay in the Philippines, the Santa Gertrudis cows had an average heat tolerance index of 90 and a mean respiration and pulse rates of 29.6 and 63.7 a minute, respectively. The average heat tolerance index of the animals was found to be 88.7 on their third year's stay.[5]

Results of the heat tolerance tests on other breeds of cattle imported into the Philippines are tabulated in table 5 for comparison.

TABLE 5.—*Average heat tolerance indices, respiration, and pulse rates for imported cattle in the Philippines. (Iberia heat tolerance test.)*

BREED	HEAT TOLERANCE TEST	RESPIRATION RATE	PULSE RATE	AUTHORS
		per min.	*per min.*	
Holstein cow	72.50	92.01	65.95	Lapuz, L., 1955 [6]
Holstein heifer	63.80	92.14	63.87	—ditto—
Holstein bull	68.07	82.53	—	Mangahas. 1953 [7]
Jersey bull	72.70	97.50	—	—ditto—
Jersey	74.10	87.93	83.13	Meyers, W., 1953 [8]
Brown Swiss	79.00	64.43	77.75	—ditto—

Materials and methods. This study was conducted at the Canlubang Sugar Estate in the summer of 1958. The animals used were grouped according to their blood composition as follows: Philippine, ½ Santa Gertrudis-½ Philippine, ½ Santa Gertrudis-½ (Philippine × Nellore), and pure Santa Gertrudis; each group being represented by five male calves approximately a year old. All were unsexed except the pure Santa Gertrudis calves. Coat conditions of the animals, except the color, were apparently similar. The Philippine calves were brown; the Santa Gertrudis-Philippine, red; the Santa Gertrudis-(Philippine × Nellore), brindled red with a background of light brown; and the pure Santa Gertrudis, dark solid red.

[5] J. C. Madamba, G. V. Garcia, M. Manresa Jr., L. L. Calo, and A. S. Achacoso, "A three-year study on the body temperature, heat tolerance, pulse and respiration rates of Santa Gertrudis cattle in the Philippines," 1957 (Read at the Ninth Pacific Science Congress. Bangkok, Thailand.)

[6] Gaudencio R. Lapuz, "A study of the heat tolerance of Holstein cows and heifers at Alabang Stock Farm." (Thesis presented for graduation, U. P. College of Veterinary Medicine, 1955. Unpublished.)

[7] Ruperto S. Mangahas, "Study of the heat tolerance of imported bulls at Alabang Stock Farm." (Thesis presented for graduation, U. P. College of Veterinary Medicine, 1953. Unpublished.)

[8] Walter Meyers, "Further preliminary studies on the heat tolerance of Jersey, Holstein. Sahiwal, and Brown Swiss cattle in the Philippine Islands." (Thesis presented for graduation, U. P. College of Veterinary Medicine, 1953. Unpublished.)

These calves were kept entirely on pasture with their respective herds.

The four groups of animals were subjected to a 3-day Iberia Heat Tolerance Test during the bright summer days of April when the atmospheric temperature in the shade ranged from 86 to 97° Fahrenheit and the relative humidity rating, from 55 to 62 per cent. There was little or no air movement at the site of work during the test.

The calves tested were placed in an open corral directly exposed to sunlight and had access to feed and water. At 10:00 a.m., the animals were directed into an open chute without undue disturbance and the body temperatures, pulse, and respiration rates were obtained. The animals were then returned to the corral and kept there until 3:00 p.m. when the body temperature, pulse, and respiration rates were again observed.

The body temperature was determined by inserting a veterinary clinical thermometer full length into the rectum for three minutes; the pulse rate, by counting the pulsation of the coccygeal artery for 15 seconds at three different times and the average multiplied by four to get the pulse per minute; and the respiration rate, by counting the rise and fall of the flanks in one minute at three different times and getting the average. Both morning and afternoon data were included in the average for each animal. The heat tolerance indices were computed according to the formula of Rhoad (1944):

$$\text{Heat Tolerance Index} = 100 - [10\ (BT - 101.0)]$$

in which BT is the average body temperature obtained under conditions of the test; 101.0 is the normal body temperature of cattle; 10 is a factor to convert degrees of variations in body temperature to a unit basis; and 100 is a perfect efficiency in maintaining body temperature at 101.0° Fahrenheit.

Results and discussion. Heat tolerance indices of the calves tested are presented in table 6. The mean heat tolerance index of Philippine calves is 82.96; the Santa Gertrudis-Philippine, 80.44; the Santa Gertrudis-(Philippine × Nellore), 80.80; and the pure Santa Gertrudis, 80.80. The indices among groups do not show any significant differences, suggesting that the pure Santa Gertrudis and crosses are as tolerant to heat as Philippine cattle.

TABLE 6.—*Comparative heat tolerance index of the Philippine, Santa Gertrudis, and Santa Gertrudis-sired calves*

ANIMAL NO.	PHILIPPINE	SANTA GERTRUDIS-PHILIPPINE	SANTA GERTRUDIS-(PHILIPPINE × NELLORE)	PURE SANTA GERTRUDIS
1	79.0	80.8	80.8	77.2
2	80.8	80.8	82.6	77.2
3	86.2	80.8	84.4	82.6
4	88.0	80.8	80.8	84.4
5	80.8	79.0	75.4	82.6
Mean	82.96	80.44	80.80	80.80

The heat tolerance index of the Santa Gertrudis obtained in this experiment is close not only to that of the Philippine cattle but also to that of the Santa Gertrudis bred and raised in the United States which is 82.[9] On the other hand, the heat tolerance index found in this experiment is much lower than that reported by M. Manresa, Jr. *et al.* (1955) and Madamba *et al.* (1957a and 1957b). This may be attributed to differences in age of the animals; those used in the previous tests being more mature. McDowell *et al.* (1955) reported that atmospheric temperature affects the body temperature of calves more seriously than that of mature ones. Bonsma (1949) stated that heat tolerance increases with age and that if a calf has a high degree of resistance and can tolerate high temperatures during its first year of life, then its power of resistance to tropical and subtropical conditions will undoubtedly be high. As shown by the heat tolerance indices, the Santa Gertrudis is apparently superior to imported temperate breeds (table 5).

The indices of individuals within the Santa Gertrudis-Philippine group are much more uniform than those of the other groups (table 6). Variance of individual indices within the Philippine group is 15.3; the Santa Gertrudis-(Philippine × Nellore), 11.3; the Santa Gertrudis, 11.3; and the Santa Gertrudis-Philippine, 0.7. The very low variability of the indices observed in the Santa Gertrudis-Philippine group indicates that they react almost similarly to heat exposure. This is to be expected since the first filial generation animals are characteristically uniform.

[9] *Santa Gertrudis Breeders International Recorded Herds*, 1, 36 (1953).

The average respiration rates of the animals obtained during the 3-day Iberia Heat Tolerance Test are shown in table 7.

TABLE 7.—*Average respiration rates of the Philippine, Santa Gertrudis, and Santa Gertrudis-sired calves exposed to direct sunlight during the Iberia Heat Tolerance Test*

ANIMAL NO.	PHILIPPINE	SANTA GERTRUDIS-PHILIPPINE	SANTA GERTRUDIS-(PHILIPPINE × NELLORE)	PURE SANTA GERTRUDIS
	per min.	*per min.*	*per min.*	*per min.*
1	55.2	46.0	50.9	62.5
2	46.0	55.0	51.2	56.2
3	33.9	46.0	53.0	36.2
4	28.6	40.8	57.4	56.7
5	28.3	46.7	49.7	43.0
Mean	38.41	46.89	52.43	50.90

HSD (5%) = 13.77

As expected, the Philippine calves showed the least respiration per minute when the atmospheric temperature in the shade was between 86 to 97° Fahrenheit. The respiration rates of the Santa Gertrudis and crosses, although significantly higher than that of Philippine calves, were very much lower than those of imported breeds (table 5).

There were no significant differences in the pulse rates among the groups of animals (table 8).

TABLE 8.—*Average pulse rates of the Philippines, Santa Gertrudis, and Santa Gertrudis-sired calves when exposed to direct sunlight during the Iberia Heat Tolerance Test*

ANIMAL NO.	PHILIPPINE	SANTA GERTRUDIS-PHILIPPINE	SANTA GERTRUDIS-(PHILIPPINE × NELLORE)	PURE SANTA GERTRUDIS
	per min.	*per min.*	*per min.*	*per min.*
1	70.7	70.7	67.3	72.0
2	68.0	67.3	74.7	72.7
3	68.0	76.7	70.0	71.3
4	69.3	70.0	72.7	69.3
5	67.2	76.7	70.0	72.7
Mean	68.53	72.27	70.93	71.60

Conclusion. Pure Santa Gertrudis calves, including those sired by the breed, are as olerant to heat as Philippine calves. Santa Gertrudis sires would be ideal for upgrading as they are not adversely affected by exposure to hot and humid climate, unlike other breeds of temperate origin.

III. GROWTH RATE

Recent studies show the resistance of the Santa Gertrudis breed when exposed to hot and humid climate. In terms of hemoglobin indices and leucocyte and erythrocyte values, the breed is definitely superior to others of exotic origin which have been brought into this country. This is also true with regard to heat tolerance indices and pulse and respiration rates. As a supplementary to these findings, this investigation was conducted from April, 1956 to March, 1959 to determine the growth of the Santa Gertrudis and crosses under local conditions.

Materials and methods. A total of 85 heads, 48 females and 37 males, were studied. The animals were grouped into four lots as follows: Philippine; ½ Santa Gertrudis-½ Philippine; ½ Santa Gertrudis-½ (Philippine × Nellore); and pure Santa Gertrudis. The heart girth and body length were measured on every first Monday of the month until the animals were one year of age. An additional observation was made on representative steers of the groups at two years of age. In the absence of a livestock scale at the site of work, monthly body weights were estimated according to the formula of Morris and Zavoral (1948) converted into kilograms:

$$\text{Body weight in kilograms} = \frac{\text{Heart girth (inches)}^2 \times \text{Body length (inches)}}{660}$$

The animals were weaned at six months old and kept entirely on pastures with mineral supplements.

Results and discussion. At the three growth periods observed, the pure Santa Gertrudis calves consistently showed the highest daily gains; the Santa Gertrudis-Philippine × Nellore calves, second; the Santa Gertrudis-Philippine calves, third; and the Philippine calves, lowest (table 9). The four groups of calves showed decreasing daily gains as they matured from weaning to two years of age.

The Santa Gertrudis-Philippine, the Santa Gertrudis-(Philippine × Nellore) and the pure Santa Gertrudis calves at weaning

time gained on the average 0.03, 0.20, and 0.37 kilograms more per day, respectively, than the Philippine calves. Following the same order the calves at one year of age gained 0.07, 0.18, and 0.30 kilograms and at two years old, 0.09, 0.13, and 0.22 kilograms more per day, respectively, than the Philippine calves.

TABLE 9.—*Average daily gains of Santa Gertrudis-sired cattle at different ages*

	PHILIPPINE	SANTA GERTRUDIS-PHILIPPINE	SANTA GERTRUDIS-(PHILIPPINE × NELLORE)	PURE SANTA GERTRUDIS
One month-old calves				
Ave. age in days	25.0	26.0	21.0	33.0
Ave. live wt. (kg.)	19.1	31.0	42.1	58.9
No. of animals	11.0	27.0	14.0	31.0
Weanlings				
Ave. age in days	170.0	184.0	178.0	181.0
Ave. live wt. (kg.)	75.6	97.6	134.9	171.9
Ave. daily gain from 1 month old (kg.)	0.39	0.42	0.59	0.76
Yearlings				
Ave. age in days	362.0	360.0	359.0	360.0
Ave. live wt. (kg.)	120.4	155.2	206.0	255.2
Ave. daily gain from 1 month old (kg.)	0.30	0.37	0.48	0.60
Two year-old steers[a]				
No. of animals	5.0	10.0	5.0	6.0
Ave. age in days	727.0	758.0	768.0	661.0
Ave. live wt. (kg.)	216.6	300.0	346.7	371.8
Ave. daily gain from 1 month old (kg.)	0.28	0.37	0.41	0.50

[a] Except the Santa Gertrudis which are entire.

To reduce the data obtained on comparable basis, the body weights were adjusted according to age. The age-adjusted body weights are presented in fig. 1. At 180 days, the Santa Gertrudis-Philippine calves on the average were 16.4 kilograms or 20.6 per cent heavier than the Philippine calves; the Santa Gertrudis-(Philippine × Nellore), 56.6 kilograms or 71.2 per cent; and the pure Santa Gertrudis calves, 91.6 kilograms or 115.2 per cent. At 365 days of age, the Santa Gertrudis-Philippine cross on the average were heavier than the Philippine cattle by 35.8 kilograms or 29.5 per cent; the Santa Gertrudis-(Philippine × Nellore), by 87.6 kilograms or 72.7 per cent; and the pure Santa Gertrudis, by 136.9 kilograms or 112.9 per cent. At 730 days of age, the Santa Gertrudis-Philippine

cross weighed more by 64.6 kilograms or 18.7 per cent; the Santa Gertrudis-(Philippine × Nellore), by 106.1 kilograms or 47.2 per cent; the pure Santa Gertrudis, by 181.3 kilograms or 80.6 per cent. The pure Santa Gertrudis cattle were consistently the heaviest among the groups, followed closely by the Santa Gertrudis-(Philippine × Nellore) cross (fig. 1). There is not much heterosis observed in the

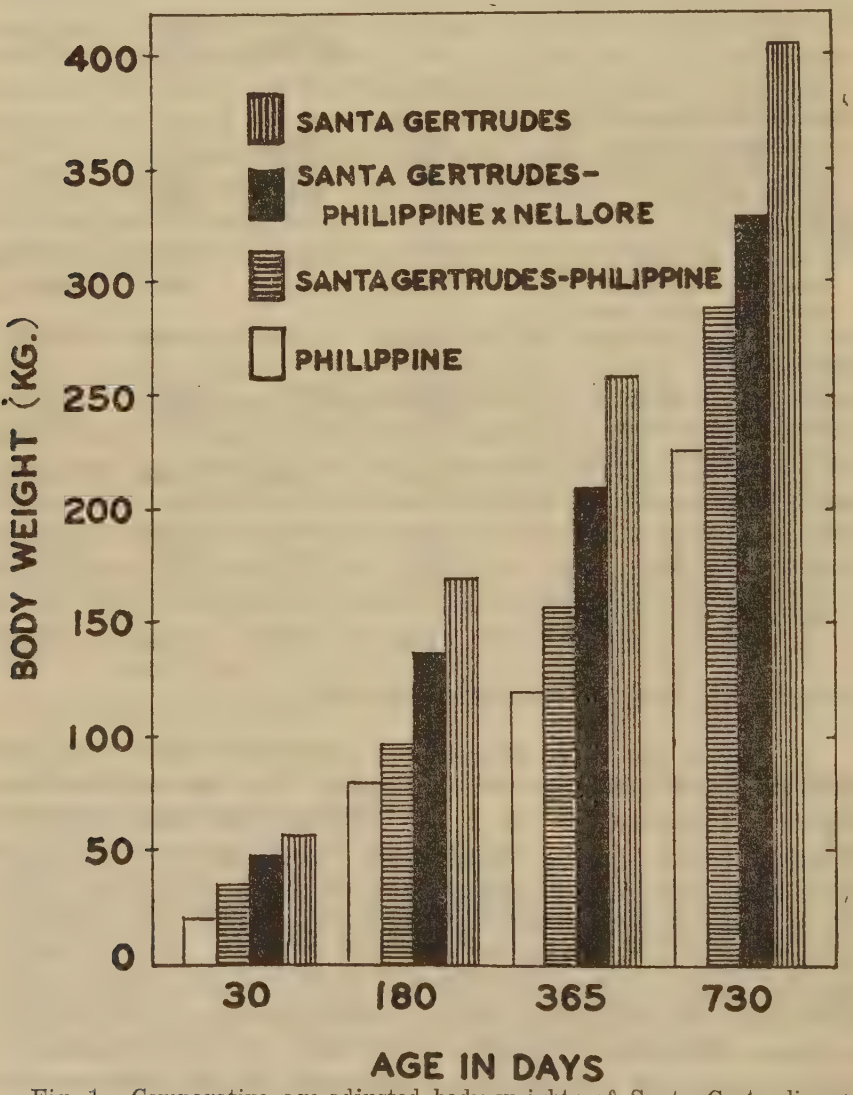

Fig. 1.—Comparative age-adjusted body weights of Santa Gertrudis and its sired cattle under pasture condition.

Santa Gertrudis-Philippine F_1 cross. This is to be expected since not much selection has been done in our Philippine stock to make them distinctly homogeneous. Compared with the growth of Santa Gertrudis-Philippine cross, the Santa Gertrudis-(Philippine × Nellore) group were definitely superior from weaning time up to two years of age. A heavier market animal resulted from the use of Santa Gertrudis bulls on Philippine-Nellore cows than on Philippine cows. This should be of interest to Filipino farmers since the majority of the cattle population are Philippine-Nellore grades.

Conclusion. The pure Santa Gertrudis cattle on the average weighed double that of the Philippine cattle from one month old to two years old. Infusing the Santa Gertrudis blood with the Philippine or the Philippine-Nellore grades substantially improved the beefing qualities of the herd. There is no doubt that in this breed we have the size and qualities that would go a long way in upgrading our indigenous beef animals. The fact that the Santa Gertrudis can be raised pure, under proper management practices, will help boost the cattle industry of the country.

GENERAL DISCUSSION

In this study, it is apparent that the Santa Gertrudis cattle is not adversely affected by the tropical climate we have here in the Philippines as indicated by their blood picture, heat tolerance, and their growth rate. The hemoglobin indices and the leucocyte and erythrocyte counts of the Santa Gertrudis cattle and its crosses with the indigenous cattle were not only within the established normal ranges for cattle but were also found to be not significantly different from that of the Philippine cattle. Likewise, the heat tolerance indices obtained for the Santa Gertrudis and its crosses were similar to that of the Philippine cattle. The growth rates of the Santa Gertrudis and its crosses with the indigenous cattle were markedly better than that of the Philippine cattle. The body weight of pure Santa Gertrudis from one month to two years of age on the average was consistently double that of the Philippine cattle. The progenies derived from the cross of Santa Gertrudis and the Philippine Nellore grades were about one and three fourths and the Santa Gertrudis-Philippine crosses were one and one third times as heavy as the Philippine cattle.

Grass-fed under Philippine conditions, the pure Santa Gertrudis cattle exhibited a performance comparable to the behavior of the

breed in the United States where it was developed. This is a rarity since most of the improved exotic breeds brought into the country failed to continue their satisfactory performance under our warm tropical climate. The first batch of Santa Gertrudis cattle imported in 1953 by the Canlubang Sugar Estate has shown, until the present, no sign of deterioration and has maintained a calf crop of about 80 per cent.

The Santa Gertrudis is an answer to the crying need for an improved breed of cattle that is able to live and multiply under tropical conditions. This need was first realized even as early as 1920 by the late Professor B. M. Gonzalez of the University of the Philippines who initiated the development of the "Philamin" to replace the inferior native strains but which was exterminated during the last war. Among the improved breeds of cattle that have come within our reach, the Santa Gertrudis is the most ideal breed to use in upgrading our indigenous cattle since it has the size and adaptability to our conditions. Being adaptable, the Santa Gertrudis cattle can be raised pure; thus, replacement of bulls for the upgrading program may be obtained and their population increased with less importation. With the use of this breed, there is all the hope that we can elevate the quality of our cattle population in the Philippines at par with those of the temperate countries.

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THE EFFECT OF SEASON OF CALVING AND ADVANCING LACTATION ON MILK PRODUCTION OF DAIRY CARABAOS AND COWS [1]

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L. L. Clamohoy, and F. B. Sarao [2]

There was a significant difference in milk production of both carabaos and cows calving during the dry and wet seasons. The carabao in the dry season gave 620.28 ± 67.43 kilograms as compared with 435.51 ± 30.03 in the wet. The corresponding productions of the cows were 1384.55 ± 109.87 and 875.75 ± 119.85 kilograms.

The Murrah carabaos attained the peak of production during the third month while the grade Murrah reached their highest level on the fourth month of the lactation period. All the breeds of cows had the highest peak of production during the second month.

Knowledge of the level of milk production of animals in a dairy herd is important because it will serve as the basis for selecting animals that are high producers and selection may enhance purification of the genes for milk production. Production records for various breeds in other countries cannot be used as an accurate gauge for the level of production to expect of the breeds here because environmental conditions and management practices in those places differ from those of the Philippines. For example, Eckles and Anthony (1950) estimated the average milk productions of the Holstein and Brown Swiss in the United States to be 3800 and 3100 kilograms respectively. These production levels are high compared with those reported in tropical countries. Likewise, dairy carabaos and cows from India and Pakistan have different averages of milk production from those of the same breeds in other areas. Imported dairy animals with high production in the Philippines indicate that they are adapted to local conditions and deserve consideration in a selection improvement program. Also, seasons of calving and advancing lactation are known to exert tremendous influence on the milk production of dairy animals.

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[2] The authors acknowledge the advice given by Dr. George W. Trimberger, Visiting Professor of Animal Husbandry, in the preparation of this paper.

Because of the above reasons, a study was conducted at the U.P. College of Agriculture to find the effect of season of calving and advancing lactation on the milk production of the dairy carabaos and cows.

METHODS

Data of the College dairy herd from January, 1946 to June, 1956 were used in this report. The milk production of the grade Murrah and Murrah carabaos and that of the Holstein, Holstein-Red Sindhi, Brown Swiss, and Red Sindhi was computed for the first 300 days. A number of milking animals, especially the carabaos and the Red Sindhi, did not reach the 300-day lactation period but the milk produced during the actual days of milking was considered the total amount for 300 days.

Irrespective of the date of calving, an animal that freshened during the month was listed for that particular month in order to find the effect of season of calving on milk production. The data from the grade Murrah and Murrah carabaos were combined because the number of freshenings from one breed in each month was deemed insufficient to be treated separately. For the same reason, the cows of all breeds were grouped together.

To study the effect of advancing lactation on milk production, the amount of milk produced by each animal based on 30 days a month was computed from the date of calving until the end of the tenth month.

RESULTS AND DISCUSSION

Level of milk production. The grade Murrah produced an average of 491.7 kilograms of milk in 300 days and the Murrah carabaos 604.3 kilograms (table 1). The production of the carabaos did not include the milk suckled by the calves. The practice in the dairy herd before 1955 was to allow the calves to suck their dams during milking time to stimulate milk flow. The young calf was allowed to suck its dam to full satisfaction. As the calf got older, the time of sucking was gradually shortened. The carabaos were milked only once a day. From 1955 to June, 1956, a few carabaos were milked twice a day. Weaning age depended on the condition of the calf, usually when about six months old.

TABLE 1.—*Effect of advancing lactation on the monthly averages of milk produced by dairy carabaos and cows, in kilograms*

BREED	NO. OF LACTATIONS *	MONTH AFTER FRESHENING										TOTAL
		1	2	3	4	5	6	7	8	9	10	
Grade Murrah	85-47	32.6	48.1	54.8	58.8	58.3	55.0	51.8	48.4	41.8	42.1	491.7
Murrah	20-15	54.0	63.8	64.9	61.6	62.9	60.8	60.6	59.1	56.8	59.8	604.3
Holstein	15-14	244.5	282.6	250.7	227.1	194.2	173.4	172.5	157.7	149.3	133.3	1985.3
Holstein-Red Sindhi	28-22	199.5	207.4	192.4	175.3	165.8	149.1	138.2	117.9	100.7	97.0	1543.3
Brown Swiss	3-1	201.2	213.7	186.5	194.2	175.0	157.9	144.1	87.6	64.8	40.2	1465.2
Red Sindhi	43-22	76.6	79.6	70.1	62.1	57.5	53.0	44.5	40.5	32.2	31.4	547.5

* First figure indicates total number. Second figure shows the number that were in lactation during the tenth month. Averages are based on the number milking during any particular month.

Sarao (1929) reported a slightly higher production for the grade Murrah than that found in this study. His animals yielded 510.1 kilograms in 300 days. However, the Murrah in his study gave a very much lower yield of 335.5 kilograms than either breed of carabaos in this study. In Egypt, carabaos yielded 1440.9 kilograms in 354 days (Alim and Ahmed, 1954) and in Pakistan, 1705.3 in 300 days (Ashfaq and Mason, 1953).

The Holstein produced an average of 1985.3 kilograms in 300 days, the Holstein-Red Sindhi, 1543.3 kilograms, and the Brown Swiss, 1465.2 kilograms. The yield of the Red Sindhi in the same length of time was 547.5 kilograms. Considering the entire lactation period, Castillo *et al.* (1956) reported that the Holstein-Red Sindhi daughters averaged 1729.08 kilograms in 338.5 days and their dams, 522.5 kilograms in 259.3 days.

The low production of the temperate breeds of cows in the tropics is corroborated by Rice (1950) who observed that in Fiji the cows in the best herds yielded only three-fifths as much as did the higher producing herds in New Zealand. Hancock and Payne (1955) reported that six cows in New Zealand produced more than their twins in Fiji which were given the same feed, care, and management. The lower production was attributed to the high temperature in Fiji which has a yearly minimum average of 85°F. (29.4°C.) compared to 65°F. (18.3°C.) in New Zealand.

Season of calving on milk production. The carabaos that calved in the dry season (January to April) produced an average of 620.28 ± 67.43 kilograms of milk in a lactation of 300 days as compared with 435.51 ± 30.03 kilograms in the wet season (May to December) (table 2). The corresponding production levels of the sows were 1384.55 ± 109.87 and 875.75 ± 119.85 kilograms. The difference in milk production during the dry and wet seasons for either the carabaos and cows is significant. This significant difference may be explained as follows: the animals which calved during the dry season have a strong hormonal influence which provides an urge to produce at a high level during the early part of their lactation when pastures are poor. This hormonal influence decreases as the lactation advanced but the decline is at a much slower rate if good pastures, due to the rainy season, is available and provide sufficient stimulation to retard the drop in milk production at the time when there normally is a sharp decline in the lactation curve. The net result was higher production for the 300-day lactation in favor of

the dry season calving. On the other hand, during the wet season, the stimulation from good pastures and the strong hormonal level soon after calving came at the same time. Then the season of poor pastures and the time for a normal rapid decline in the lactation coincided. The combined effect of the favorable conditions in the early stage of lactation did not offset the marked decrease brought about by the adverse conditions in the later stage; hence, the marked decrease in total production of dams with wet season freshenings.

TABLE 2.—*The effect of season of freshening on the amount of milk produced by dairy carabaos and cows during a lactation of 300 days*

MONTH	CARABAOS	COWS
	kgm.	*kgm.*
January	623.7	1134.5
February	656.5	1058.8
March	511.6	1638.2
April	669.5	1548.7
Dry season average	620.28 ± 67.43	1384.55 ± 109.87
May	—*	741.9
June	490.6	590.7
July	447.4	1492.7
August	504.8	802.5
September	472.6	1068.0
October	404.3	1142.2
November	409.2	852.9
December	402.0	781.6
Wet season average	435.51 ± 30.03	875.75 ± 119.85

* Excluded in the computation because there was only one lactation.

Furthermore, there were significant differences in the atmospheric temperature, rainfall, and relative humidity of the two seasons as shown in table 3 taken from the Meteorological Division, Department of Agricultural Engineering.

The data show that it is cooler and less humid in the dry season than in the wet season. Apparently, the animals during the dry season are more comfortable than in the wet. These findings are corroborated by the reports from other countries that carabaos calved in the cool season, November to March (Alim and Ahmed, 1954) or December to April (Ashfaq and Mason, 1953) have high yields compared with those calving in summer. With regard to cows, Ragsdale, *et al.* (1948) found that temparatures above 75°F (23.9°C.)

and high humidity depressed feed consumption and milk production in dairy cows. In Puerto Rico, Gaztambide-Arrillaga *et al.* (1950) reported higher milk production during winter.

TABLE 3.—*Average monthly temperature, rainfall, and relative humidity at the U. P. College of Agriculture from January, 1946 to June, 1956*

MONTH	TEMPERATURE	RAINFALL	RELATIVE HUMIDITY
	°C.	*mm.*	*per cent*
January	25.02	48.69	80.7
February	25.75	23.98	75.8
March	26.70	30.77	72.0
April	28.34	36.23	69.5
Average for dry season	26.45 ± 0.21	34.92 ± 1.41	74.5 ± 0.94
May	28.78	138.37	73.8
June	28.30	202.61	78.5
July	27.80	183.86	80.5
August	27.02	274.97	81.5
September	27.00	193.97	82.9
October	26.86	248.38	82.6
November	25.98	250.76	82.6
December	25.21	163.21	83.7
Average for wet season	27.11 ± 0.15	207.02 ± 11.80	80.76 ± 1.23

Effect of advancing lactation. The grade Murrah carabao attained the highest production of 58.8 kilograms during the fourth month and the Murrah, 64.9 kilograms in the third month after freshening (table 1). All the cows, on the other hand, attained highest production during the second month with the Holstein producing 282.6 kilograms; Holstein-Red Sindhi, 207.4; Brown Swiss, 213.7; and Red Sindhi, 79.6. Table 1 shows that the monthly milk production decreased as lactation advanced. This might be due to the effect of advancing gestation and/or to the lessening of the hormonal influence for the maintenance of lactation as it advanced. The trend of decreasing milk production after the peak was reached agrees closely with the findings in the other tropical and temperate countries.

Season and interval of calving. Although the carabao freshened throughout the year, there is a definite seasonal trend as shown in fig. 1. Of the 173 calvings, 32 or 18.50 per cent were in October and 34 or 19.65 per cent in November. The season of calving for

the grade Murrah and Murrah was from August to December and amounted to 68.8 per cent of the total calved during the period. This is confirmed by Ocampo (1939) that most of the 88 calvings of native, grade Murrah, and Murrah carabaos occurred from September to January. Since the gestation period of carabaos is about 316 days, then the corresponding breeding season is from September to January. The carabaos included in this study were pasture-bred.

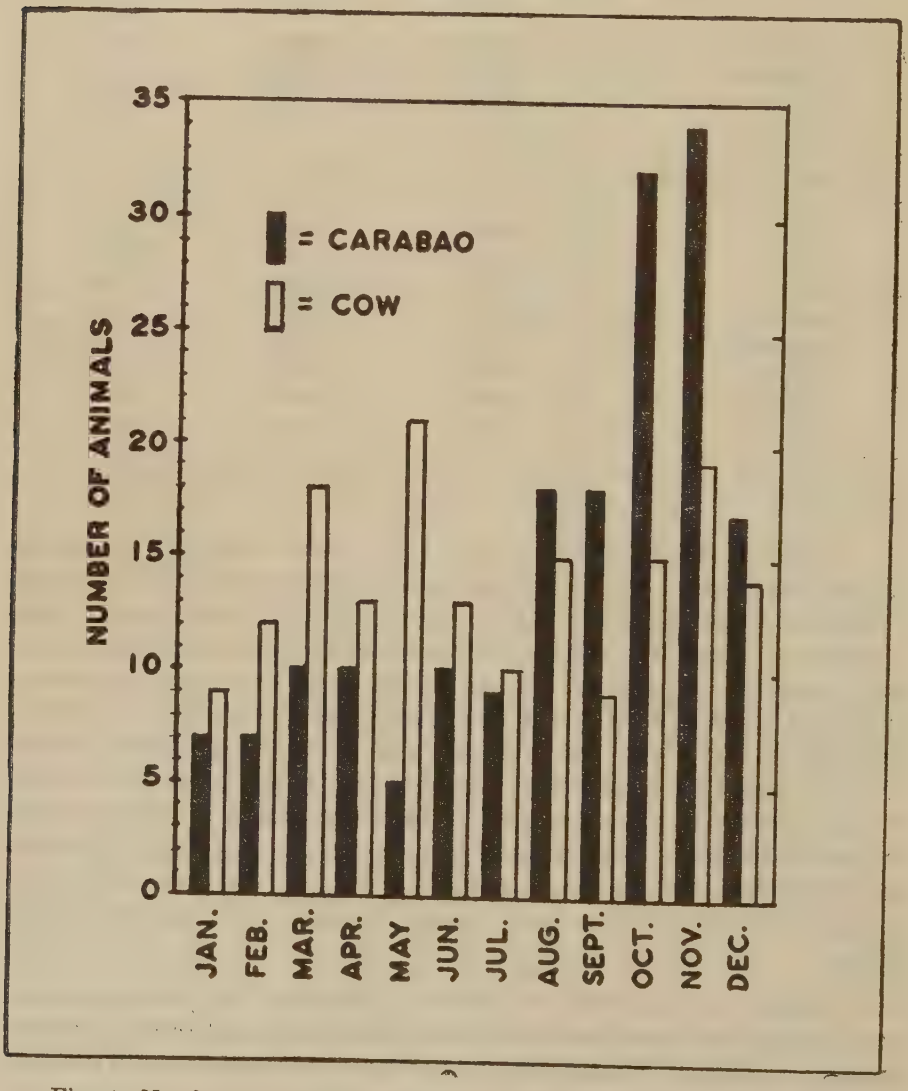

Fig. 1. Number of animals calving at different months of the year.

Although the two peaks of freshenings in May (12.93 per cent) and November (11.52 per cent) were during the wet season, the 165 calvings in cows, unlike those in carabaos, were fairly well-distributed throughout the year. This might be due to the fact that the cows were hand-bred.

There is a tendency for the calving interval in the grade Murrah to shorten from the first to the sixth lactation. The corresponding intervals were 586, 517, 518, 427, and 376 days. For all the calvings, the average was 484.8 days. No such relationship was shown in the other breeds. The Murrah had an average of 493.8 days. The Brown Swiss gave a similar interval of 493.0 days. The Red Sindhi, Holstein-Red Sindhi, and Holstein had calving intervals of 489, 411, and 573 days, respectively. The long interval for the Holstein was attributed to the failure of three cows to settle in spite of repeated services (Castillo, *et al.*, 1956).

SUMMARY

1. Data from the College dairy herd composed of carabaos and cows from January, 1946 to June, 1956 were used in this study.

2. The grade Murrah produced 491.7 kilograms and the Murrah, 604.3 kilograms in 300 days. The Holstein gave a yield of 1985.3 kilograms, the Holstein-Red Sindhi, 1543.3; the Brown Swiss, 1465.2; and the Red Sindhi, 547.5 kilograms during a standard lactation of 300 days.

3. The yield of the carabaos in the dry season was 620.28 ± 67.42 kilograms compared to 435.51 ± 30.03 during the wet season. The corresponding productions of the cows were 1384.55 ± 109.87 and 875.75 ± 119.85 kilograms. The difference in the production levels between the seasons for either the carabaos or cows is statistically significant.

4. Murrah carabaos attained the peak of production during the third month while the grade Murrah reached their highest level on the fourth month of lactation period. All the breeds of cows had the highest peak of production during the second month.

5. The carabaos showed a seasonal trend for calving during the period from August to December but the cows showed an equal distribution for calving in any month throughout the year.

6. The calving interval of the grade Murrah carabao tended to decrease from the first to the fifth calving. No such relationship was shown in the other breeds of animals studied.

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ONTOGENETIC AND EMBRYOLOGICAL STUDIES IN *THEOBROMA CACAO* LINN.[1]

P. M. Zamora, N. M. Orlido, and J. M. Capinpin

WITH FORTY-FIVE TEXT FIGURES

The floral whorls of cacao range in number of parts from 3 to 8 with the prevalence of 5 and 6. The flower has a fairly complex vascular anatomy. The view that the individual stamens represent morphological pairs closely joined together along their filaments is borne out by the double traces which they receive as observed in the current investigation.

The inflorescence primordium arises "endogenously" from the phellogen. The floral primordia are formed by the bifurcation of the inflorescence in a dichasial fashion. The sequence of development of the floral organs is acropetal. The ovule is bitegmic, crassinucellate, and anatropous. The placentation of the ovary is here interpreted as parietal in contrast to the interpretation by other workers that it is axile.

The archesporium is differentiated in the sub-hypodermal region of the massive nucellus. The single archesporial cell functions directly as the megaspore mother cell and forms a linear tetrad. The chalazal megaspore functions while the micropylar ones abort. The functional megaspore gives rise to an eight-nucleate embryo-sac of the normal type. Starch grains occur in the functional megaspore stage through the mature embryo-sac.

Recent studies on the morphology of the cacao flower have shown that the sepals, petals, stamens, and staminodes are disposed in whorls of five and that the pistil is syncarpous and multilocular with anatropous ovules and axile placentation. Little or no information is, however, available concerning the ontogeny of the inflorescence and the floral organs and the vascular anatomy of the flower. Certain phases of its embryology have been investigated by some workers but the earlier developmental stages seem to have been left uninvestigated. The present paper presents observations on these little-known aspects regarding the cacao flower. In view of the lack of appropriate description of local materials, observations on the gross morphology of the flower have been included in the present investigation.

[1] Central Experiment Station Contribution No. 2035.

MATERIALS AND METHODS

The materials utilized in this investigation were secured from both the white- and purple-flowered cacao trees (Criollo type) growing under natural conditions in the cacao experimental lot of the College of Agriculture, University of the Philippines, Los Baños, Laguna. Flowers of various stages of development were collected periodically during the blooming months from May to October, 1958. The materials for histological study were fixed and killed either in Bouin's solution or in formalin-aceto-alcohol *in toto*. They were washed in running water for several hours, passed through the ethyl alcohol-xylene series and then embedded in paraffin with 53-55° C. melting range. Serial sections cut at 12-15 microns were stained with safranin, Harris hematoxylin, Haidenhain's iron-alum hematoxylin with orange G, and safranin-fast green combination. The schedules yielded satisfactory results for each specific phase of study. Illustrations were prepared from suitable materials with the aid of the camera lucida.

OBSERVATIONS

Gross morphology of the flower. The inflorescence of *Theobroma cacao* is cymose and consists of numerous flowers but most of them fall off in time and only a few continue to develop into fruits. They are 10-25 mm. in length and 4-6 mm. in diameter. These data represent measurements of 1750 fairly mature flowers collected periodically from the trunks and old branches of different trees during the flowering season. Measurements were made from the base of the pedicel to the tip of the petals, they being the longest floral organs.

Fig. 1 is an illustration of a single cacao flower. It is polycyclic, actinomorphic hypogynous, and perfect, subtended by deciduous bracts and has a constriction at the base of the pedicel (not shown in the figure). The nature of this constriction has not been determined in this work. However, Cheesman (1932) reports that it extends almost to the vascular strands of the pedicel. The floral organs are pubescent as shown in the illustrations.

The sepals are generally 8 mm. long and 2 mm. wide. They are lanceolate in shape (fig. 3) and valvate in the bud (fig. 2). The petals are generally 10 mm. long and 3 mm. wide. The width of the perianth segments were taken by measuring their broadest portions. The petals are narrow at the base, expanded into a cup-like

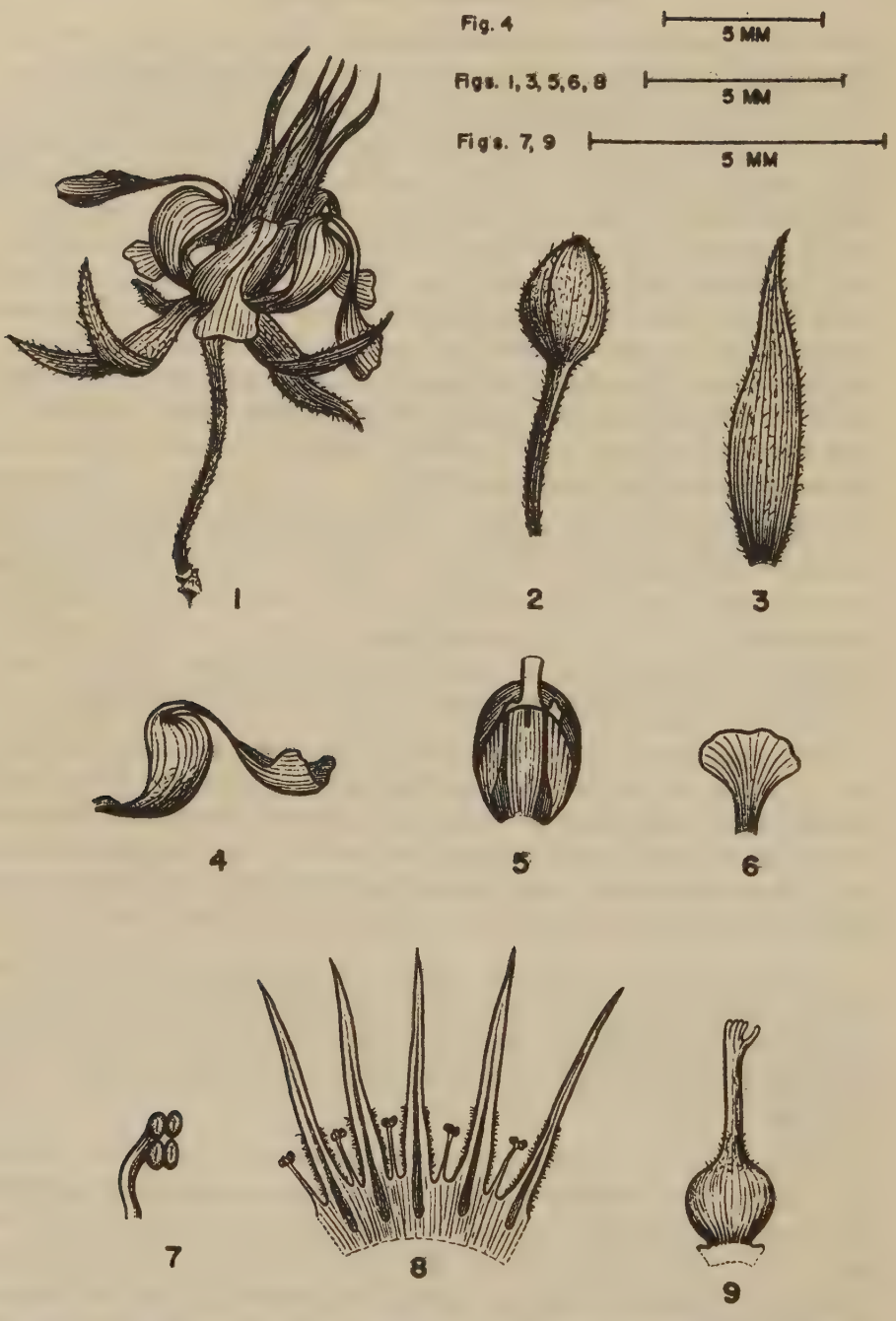
pouch, and terminate into a spatulate tip (fig. 4, 5, and 6). The androecium consists of a whorl of stamens and staminodes. These are united at the base forming a short tube around the point of attachment of the pistil to the flower stalk (fig. 8 and 16). The stamens generally measure 3 mm. in length. As shown in fig. 7 and 8, the filaments are short and terminate into bilobed anthers each with two pollen sacs. The anthers are extrorse and dehisce by longitudinal slits along their dorsal surfaces. The staminodes are more than twice longer than the stamens, being 7 mm. in length. They are erect and pointed as shown in fig. 8 and provided with purple ridges on their sides. The syncarpous pistil is commonly 4 mm. long. The ovary is superior and the ovules are anatropous (fig. 26 and 28). The carpels are prolonged into the style and terminate into five stigmatic lobes (fig. 9, 22, and 23).

Observation on the number of floral parts has been made and the data obtained are presented in table 1. The sepals range in number from 3 to 7, the petals 5 to 8, the stamens 3 to 8, and the staminodes 3 to 7, with the prevalence of 5 and 6. Previous workers reported no variation in the number of these organs in their materials. All the flowers examined are invariably unipistillate.

The positions of the floral whorls in relation to one another may be seen in fig. 17. The sepals alternate with the petals; the stamens and staminodes lie within the perianth, the former opposite the petals and the latter opposite the sepals. The petals, stamens, and carpels lie in the same radius and the sepals, staminodes, and the carpel septa lie in another radius but in the same line.

Vascular anatomy of the flower. The vascular anatomy of the flower was studied from serial transverse sections at successive levels from the pedicel to the top of the organ. As many preparations as were practicable for observations were examined for this purpose.

Fig. 10 is a transverse view of the pedicel slightly below the receptacle. The vascular cylinder of the organ at this level assumes the form of a dictyostele with five bundles of unequal sizes. Fig. 11 and 12 are transverse views of the receptacle at the level of insertion of the sepals. The sepal traces, designated ST in the figures, diverge from the stele of the receptacle, three to each sepal, one median and two lateral traces at this level. The median trace re-



Figs. 1-9.—The flower and floral organs. Fig. 1.—Habit sketch of a single flower. Fig. 2.—Flower bud. Fig. 3.—Sepal. Fig. 4.—Petal. Fig. 5.—Pouchlike portion of petal. Fig. 6.—Spatulate tip of petal. Fig. 7.—Stamen. Fig. 8.—Stamens and staminodes. Fig. 9.—Pistil.

mains distinct throughout the length of the organ while the two lateral traces give off branches so that the individual sepals have five bundles at higher levels (fig. 11-23).

TABLE 1.—*Frequency of flowers and floral parts based on the examination of 1750 flowers*

FLORAL PART	FREQUENCY OF	
	Parts	Flowers
Sepal	3	1
	4	1
	5	1710
	6	37
	7	1
Petal	5	1680
	6	60
	7	9
	8	1
Stamen	3	1
	4	6
	5	1696
	6	44
	7	2
	8	1
Staminode	3	1
	4	13
	5	1689
	6	44
	7	3

The petal traces, designated PT in fig. 12, 13, and 14, diverge next from the receptacular stele above the sepal traces. Each petal receives three traces, thus a petal has three bundles, one median and two laterals, at higher levels (fig. 15-23).

The stamen and staminodial traces diverge above the level of departure of the petal traces (fig. 14). The stamen traces are labelled SA and the staminodial traces SM in the figures. These are alternately disposed relative to one another as shown in fig. 15-17. The bundles remain distinct throughout the length of the organs (fig. 16-23).

There remain numerous bundles in the central cylinder after the stamen and staminodial traces have diverged out (RS, fig. 14). These bundles ramify repeatedly and give rise to numerous branches which become disposed into two rings at higher levels (fig. 15 and 16). The central ring (parent ring) is designated CR and the peripheral ring PR in the illustrations. The central vascular bundles unite with one another as they approach the ovule-bearing region of the ovary. Fig. 17 shows the five traces which resulted from the union. The traces become the ventral bundles of the carpels (VT, fig. 18 and 19). The peripheral traces lying opposite the ovule-bearing region also unite and become more prominent than the rest of the traces. These become the dorsal bundles of the carpels. They are designated DT in fig. 18 and 19. The less prominent ones, designated LT in the figures, remain distinct and become the lateral bundles of the carpels. As shown in the figures, these bundles are disposed more or less irregularly with respect to one another between the dorsal bundles. The lateral bundles situated opposite the placental ridges (the arrowhead-like structures in transverse views) each sends out an approximately horizontal or slightly oblique branch inward, which branch "splits" into two branchlets on approaching the ventral bundle. These branchlets "swing" outward in opposite directions, i.e., toward the placental ridge, coalesce with branches from the ventral bundles, and finally enter the ovule (fig. 18, 25, and 26). The ovular traces are designated OT in the illustrations.

The carpellary bundles (dorsal, ventral, and lateral) become smaller and weaker and finally fade out as they approach the distal end of the ovary (fig. 21 and 22). A transverse view at a certain level proximal to the tip of the stigmatic lobes is shown in fig. 23. The stigmatic lobes are parenchymatous at this level and receive no vascular supplies.

Development of the inflorescence. The inflorescence primordium appears as a hemispherical mound of meristematic cells within the periderm of old stems and at the axils of abscissed leaves in lateral branches. It is initiated by the localized active divisions of the phellogen cells in these organs. The newly-formed primordium is covered by massive cork tissues as illustrated in fig. 29. Very early in its ontogeny, the inflorescence primordium cuts off bract primordia laterally on its summit but maintains its initial outward course, pushing its way through the cork tissue above it. The bracts appear as crescentic structures at first (see fig. 30), but differen-

Fig. 10-14.—Serial transverse sections of the flower from the pedicel slightly below the receptacle upward [see text for explanation].

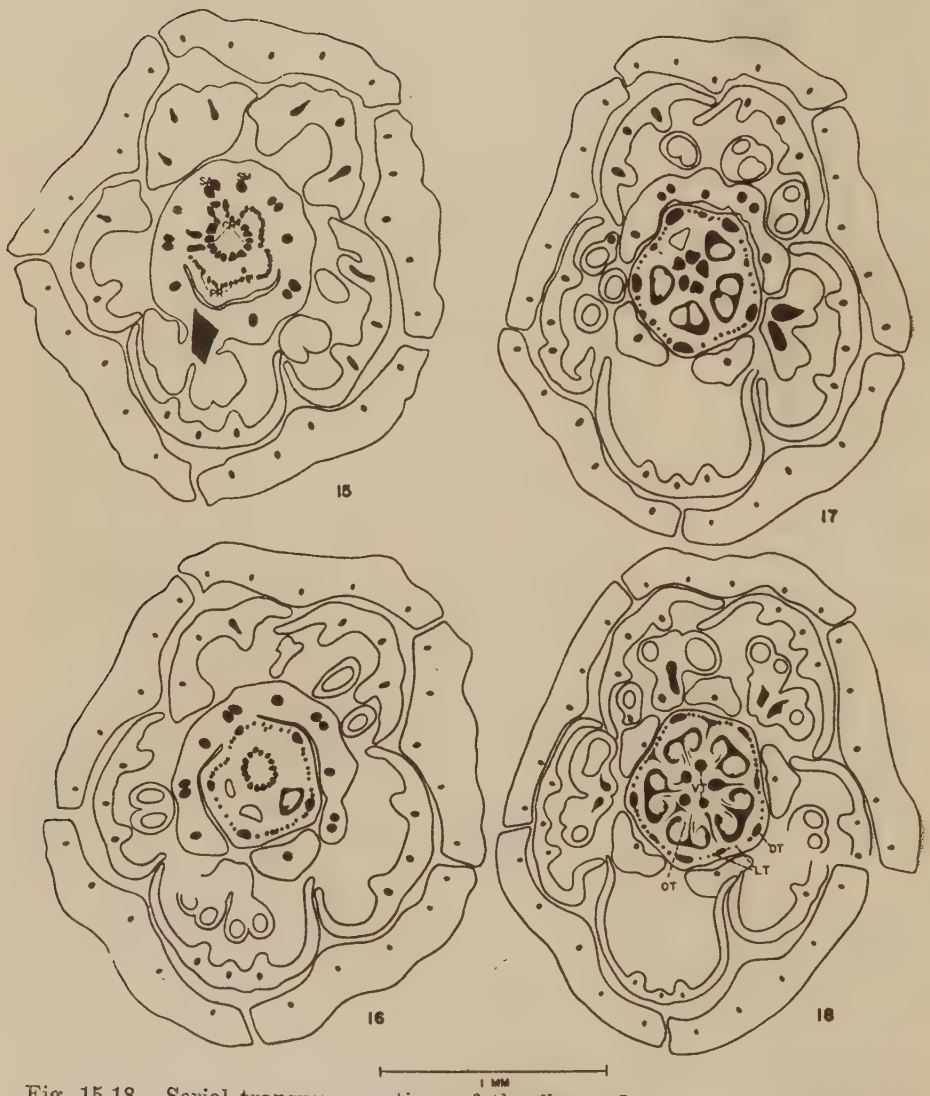


Fig. 15-18.—Serial transverse sections of the flower [continuation of fig. 10-14; see text for explanation].

Fig. 19-22.—Serial transverse sections of the flower [continuation of fig. 15-18; see text for explanation].

tiate rapidly hand in hand with the broadening of the inflorescence apex and are fully developed while the floral primordia are being organized. The bracts finally overtop the apical meristem and have completely enveloped it at the stage of development reached by the inflorescence illustrated in fig. 31. Further development of the inflorescence results in the formation of floral primordia by bifurcation of the main axis in dichasical fashion (fig. 31 and 32). Fig. 33 is a longitudinal view of a young inflorescence showing the position and the stage of development reached by the floral primordia. There are usually three to five floral primordia produced in an inflorescence, however, for the sake of convenience in illustration, only two are represented in the figure.

Sequence of initiation of floral organs. The floral primordium cuts off bract primordia shortly after it is organized in the inflorescence. The bract primordia grow rapidly and become fully differentiated before the floral organs are even visible (B-2, fig. 33). The growth of the bracts takes place rapidly on the abaxial surface so that their apices bend inward as they elongate and enclose the apical meristem of the young flower. The sepal primordia appear next to the bracts as lateral lobes in a single whorl within the latter. In the same manner as the bracts, the sepals elongate rapidly and by the time they have enclosed the floral apex beneath them, the other floral organ-primordia appear (B-1, fig. 33). The stamen, staminode, and pistil primordia are initiated simultaneously within the calyx as depicted in fig. 34.

Development of the ovule. The ovule appears as small dome-like protruberance from the placenta and grows directly as a straight structure into the space opposite it in the young ovary. Fig. 24 is a transverse section of the young ovary taken at a level midway between its basal and apical portions showing the position assumed by the two ovular primordia in each of the individual carpels. As shown in fig. 24-26 the ovary has five carpels each with two vertical columns of ovules. In a later stage, the ovule becomes projected laterally at an angle of approximately 45° as a result of differential growth. Fig. 25 and 26 illustrate the divergent course of the two ovular primordia in each carpel so that their apices become oriented in opposite directions. The integuments and the nucellus are already well developed by the time the ovule had assumed this position (fig. 27). The ovule continue its curving growth until it becomes completely inverted so that the integuments and nucellus

lie alongside the funiculus with the micropylar end directed towards the placental wall (fig. 26 and 28).

The two integuments participate in the formation of the micropyle (fig. 27 and 28). The outer integument is less massive than the inner one and is only slightly developed on the funicular side of the ovule but its growth is arrested before it reaches the summit of the nucellus on the side opposite the funiculus. The more developed portions of the integuments are in direct contact with the apex of the nucellus at a certain level. Fig. 28 shows the two integuments approaching each other a little distance above the nucellar apex but are not in contact with each other so that a space is left in the position of the micropylar end. The nucellus is massive and forms a prominent conical apex at the micropylar region in a more advance stage of development.

Placentation. A series of transverse views at successive levels from the base to the tip of the ovary are illustrated in fig. 16-19. The carpel margins are completely fused at the lower third of the ovary as illustrated in fig. 17 and 18; thus, the gynoecium appears multilocular at this level of the ovary. Fig. 19 is a transverse view representative of the upper two-thirds of the ovule-bearing region of the ovary. The carpel margins are free from each other leaving a cavity or hollow in the center. The hollow extends to the style and stigma (fig. 21). This condition gives the impression that the ovary is unilocular. The placentae clearly appear to arise from the fused margins of the different carpels. The ventral bundles lie on different radii from those of the dorsal bundles throughout the length of the ovary, with the phloem oriented towards the interior and the xylem towards the exterior with respect to the floral axis.

Megasporangium. The archesporium differentiates in the third layer of cells immediately beneath the summit of the nucellus. A single archesporial cell appears soon after the nucellus has prominently protruded from the placenta and before the integuments are initiated (fig. 35). It is polygonal in shape and is easily recognized from the neighboring nucellar cells by its large size and its possession of a distinctly large nucleus and densely granular cytoplasm. This archesporial cell undergoes no further division and functions directly as megaspore mother cell. Soon after its appearance in the nucellus the megaspore mother cell increases considerably in size during which the nucellar cells in contact with it become more or less stretched (fig. 36). It undergoes two successive

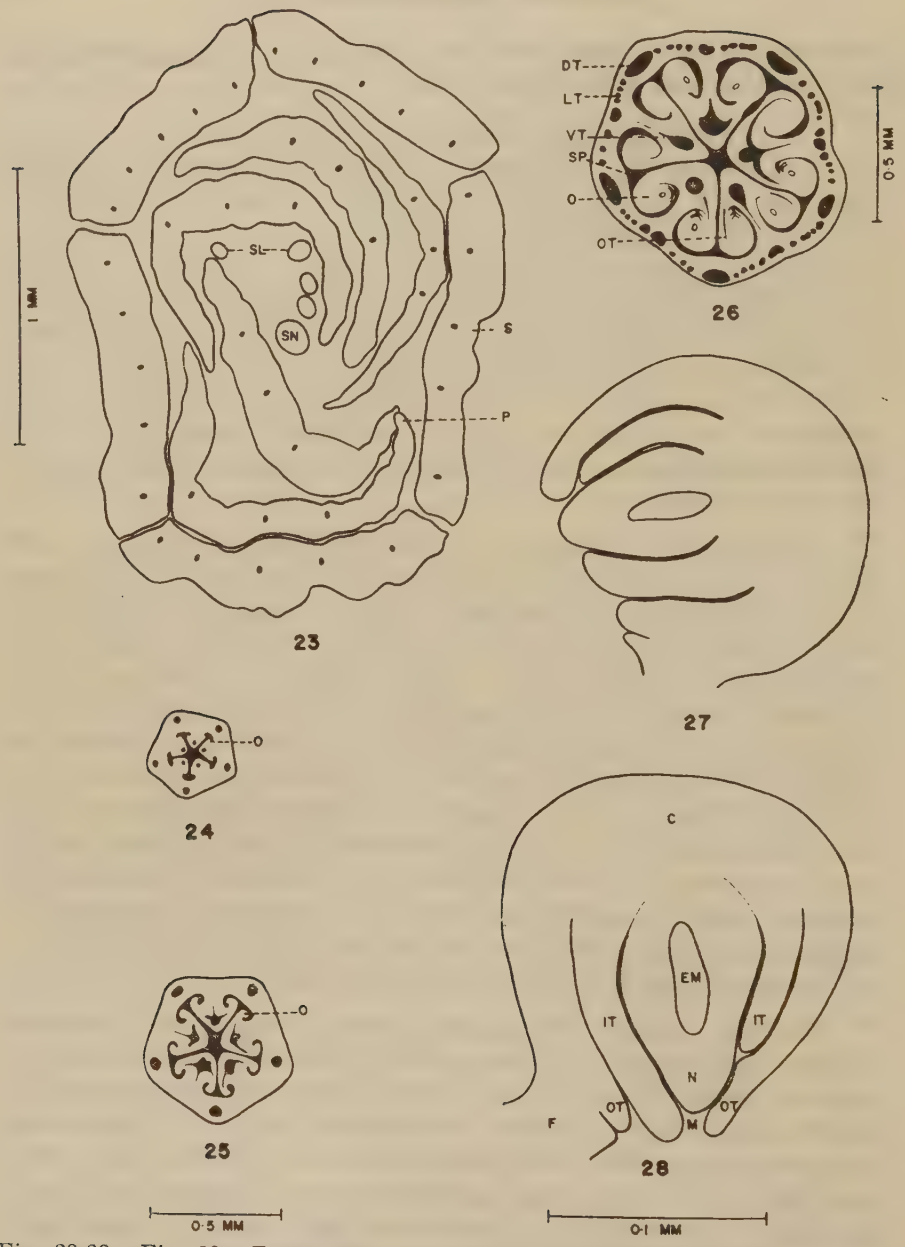


Fig. 23-28.—Fig. 23.—Transverse section taken some distance proximal to the tip of the flower [continuation of fig. 19-22]. Fig. 24, 25, and 26.—Transverse sections of ovaries at three stages of development taken midway between their basal and terminal portions showing the course of growth of the ovules. Fig. 27.—An ovule oriented at an angle of approximately 45°. Fig. 28.—An anatropous ovule. *Explanation to abbreviations:* SL, stigma lobes; SN, staminode; P, petal; S, sepal; O, ovule; DT, dorsal bundle; LT, lateral bundle; VT, ventra bundle; OT [fig. 26], ovule trace; SP, space; C, chalaza; F, funiculus; EM, embryo-sac; N, nucellus; M, micropyle; OT [fig. 28], outer integument; IT, inner integument.

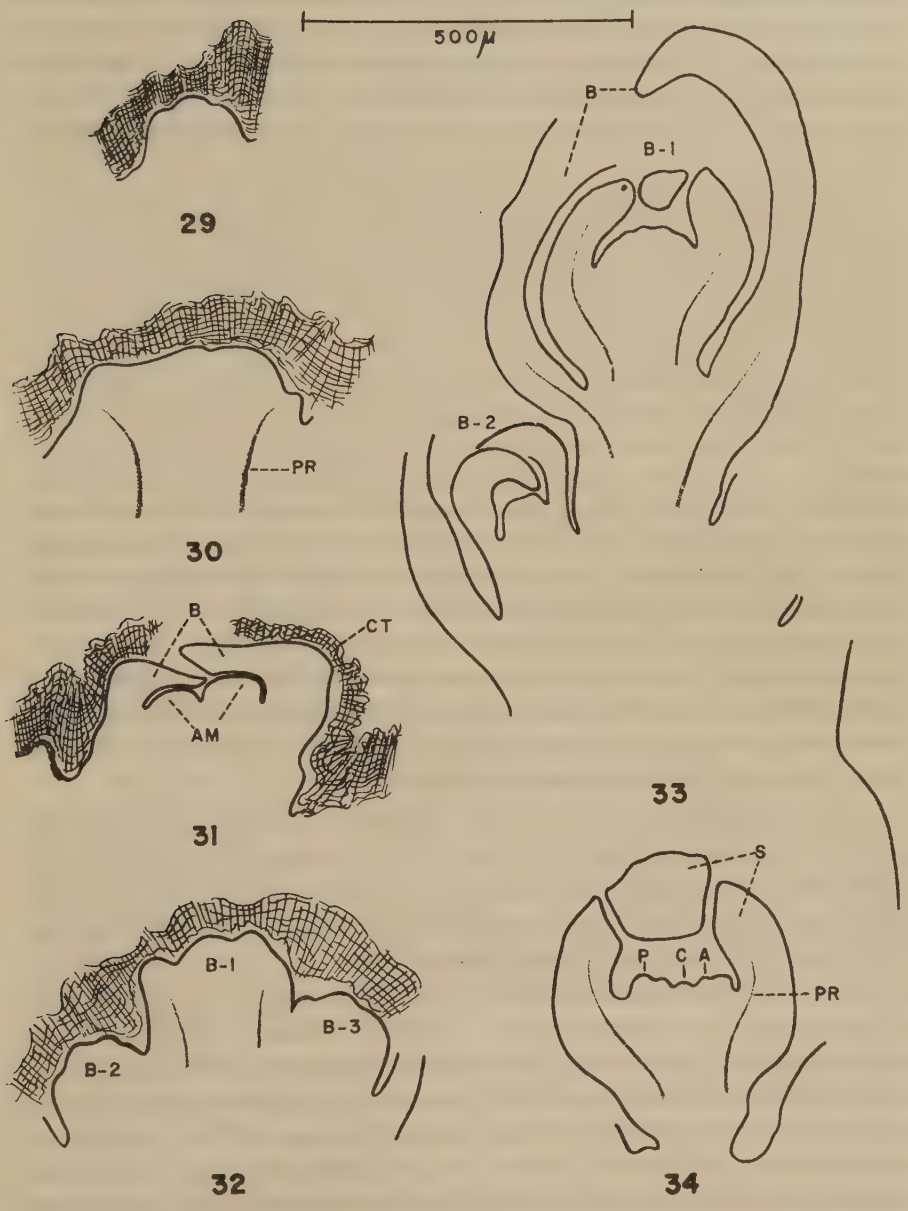


Fig. 29-34.—Longitudinal views showing stages in the development of the inflorescence. *Explanation to abbreviations:* PR, procambial strand; B, bract; CT, cork tissue; B-1, B-2, and B-3, floral primordia; S, sepal; P, petal primordium; C, pistil primordium; A, stamen or staminodial primordium.

divisions and gives rise, first to a dyad (fig. 37) and then to a linear tetrad of megaspores (fig. 38). The writers failed to determine the number of chromosomes due to the scarcity of meiotic figures in the materials. Theoretically, however, reduction division takes place so that each of the megaspores is haploid. Simmonds (1954) reported that *Theobroma cacao* has a haploid chromosome number of 10.

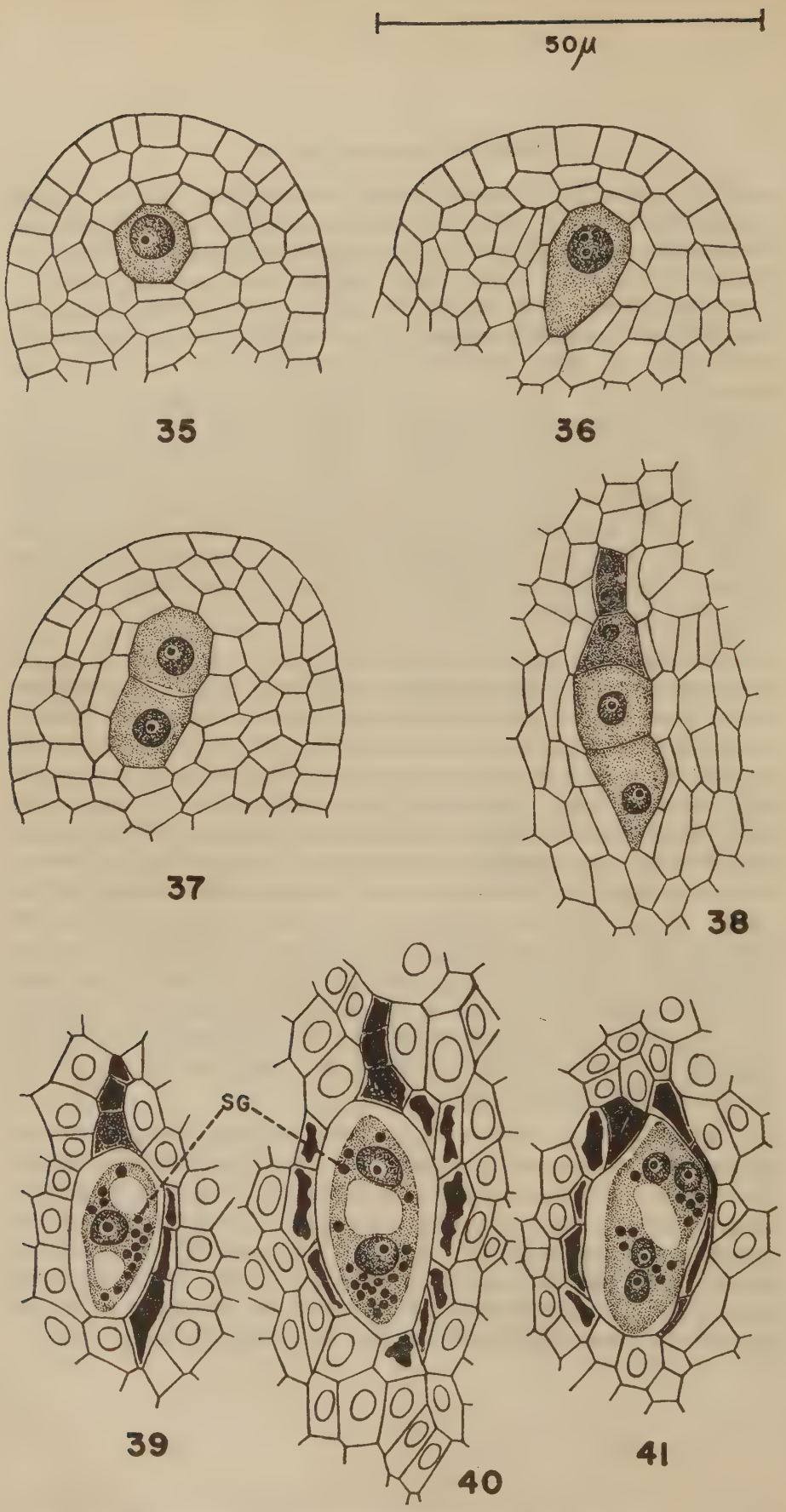
Embryo-Sac: structural development. Shortly after tetrad formation, the proximal megaspore enlarges whereas the three distal megaspores degenerate one after the other in basipetal succession. Fig. 39 illustrates the large functional megaspore and the three abortive micropylar megaspores, the latter forms a cap over the former as a small patch of darkly stained mass of cells. The functional megaspore possesses a conspicuous, deeply stained, and centrally located nucleus, vacuoles, and numerous starch grains embedded and distributed throughout the cytoplasm. The distribution of starch grains is treated elsewhere in the paper. The cytoplasm has shrunk so that a space is formed between it and the surrounding wall. The space is an artifact as a result of improper fixation and is certainly not a cytological feature as illustrated in the figure. Degeneration of the nucellar cells around the enlarging megaspore is first manifest in this stage and continues in the later stages. The degenerating cells have darkly stained contents in preparations. No intervening stages have been observed probably because the subsequent divisions occur in rapid succession.

The nucleus of the functional megaspore divides shortly after the cell has enlarged and gives rise to the two-nucleate embryo-sac. In fig. 40, the two daughter nuclei are shown migrating to the poles and appear separated by a large central vacuole. Each of the two nuclei, in turn, divides simultaneously forming the four-nucleate embryo-sac. Fig. 41 shows the two pairs of daughter nuclei, one pair to each pole, also separated by a central vacuole. The nuclei at the micropylar region lie side by side with each other while the nuclei at the chalazal region are arranged one above the other in relation to the vertical axis of the embryo-sac. The manner of orientation of the mitotic figures in the embryo-sac at the time of division probably accounts for the position assumed by the resulting products or nuclei in the illustration. Fig. 42 shows the eight-nucleate embryo sac formed as a result of the simultaneous divisions of the nuclei in the preceding stage. The embryo sac illustrated in

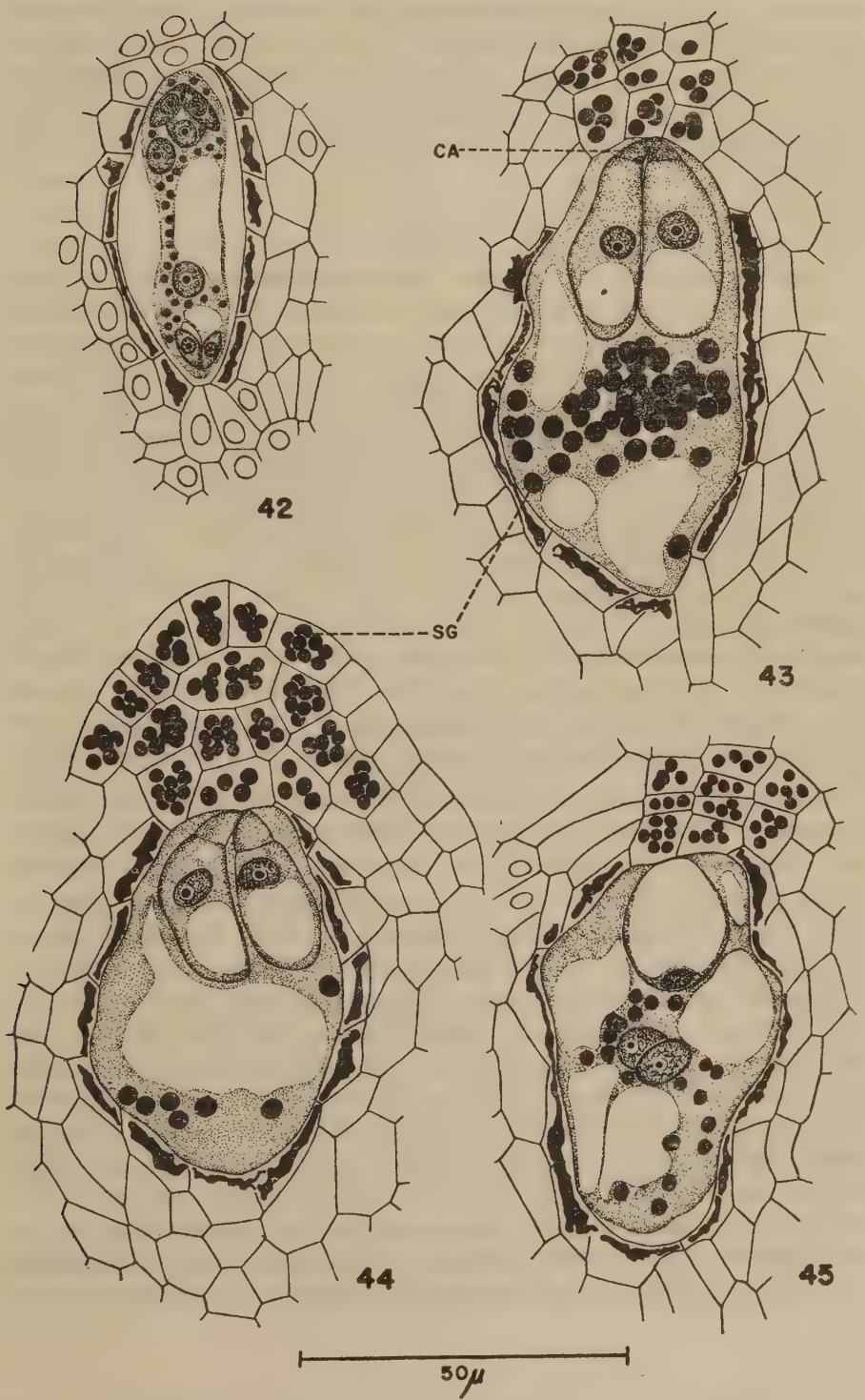
the figure is a reconstruction from two adjacent sections of the same ovule in the series. The eight nuclei appear separated from one another by faintly stained membranes. One of the four micropylar nuclei and one of the four chalazal nuclei are proceeding toward the center of the embryo sac. These are the polar nuclei. The egg cell and the two synergids become oriented at the micropylar region and the three antipodal cells at the chalazal region of the embryo sac. Fig. 43 is a near-radial longitudinal view of a mature embryo sac containing the egg apparatus and the polar nuclei. Fig. 44 and 45 are similar views of two adjacent sections of the same ovule, the former containing the two synergids and the latter, the egg and the two polars. It is often difficult to obtain sections of embryo sacs complete with their contents because the cells lie one above the other in the cytoplasm (fig. 43). The antipodals are ephemeral and have completely disappeared in the embryo sacs illustrated in figures 43, 44, and 45.

The complete egg apparatus is strikingly large. The synergids are approximately oblong in shape, with "caps" and dense cytoplasm at the proximal end, and vacuoles at or near the center just beneath the vacuolated portions (fig. 43 and 44). The egg cell is more or less round to oval in shape, the greater bulk of which is occupied by a large vacuole. The nucleus is embedded in a thin peripheral cytoplasm at the distal portion of the cell. The egg cell lies behind and between the synergids as illustrated in fig. 43 or vice versa, depending upon the manner in which the sections are affixed on the slide. The polars are round to oval in shape with deeply stained nucleoli (fig. 45). As shown in this figure and in fig. 43, they lie close together in the central region of the embryo sac. Hakansson (1947) observed that the polar nuclei, in the material he examined, lie in the vicinity of the egg apparatus; they later move to a position near the chalazal end after fertilization where the first division of the endosperm nucleus occurs.

Starch grains. Microchemical tests involving iodine-potassium iodide solution showed the presence of starch grains in the embryo sac. These inclusions are first evident in the enlarging functional megaspore cell, about the stage when the abortive megaspores are progressively degenerating (fig. 39). They seem to increase in amount with the progress of development of the embryo sac (fig. 40, 41, and 42) and are most abundant in the mature embryo sacs at about the stage represented in fig. 43. They are often clustered



Figs. 35-41.—Stages in the development of the embryo sac [see text for explanation]. SG, starch grains.



Figs. 42-45.—Stages in the development of the embryo-sac [continuation of figures 35-41; see text for explanation]. SG, starch grains; CA, synergidal "cap".

around the polar nuclei and the egg cell, rendering observation on the latter structures rather difficult. In only very few instances was the embryo sac in the position of the polar nuclei observed to contain no starch grains. Starch grains also occur in the nucellar cells immediately above the egg apparatus as shown in fig. 43, 44, and 45.

DISCUSSION

Gross morphology of the flower. Cheesman (1932), Chatt (1953), Gnanaratnam (1954), and Urquhart (1955) described the flower of *Theobroma cacao* as polycyclic, actinomorphic, hypogynous, and hermaphroditic. The observation of the present writers conformed with the foregoing description. The floral organs were consistently reported to occur in whorls of five by the afore-mentioned workers. In the writers' materials, the sepals and staminodes varied in number from 3 to 7, the petals from 5 to 8, and the stamens from 3 to 8, with the prevalence of 5 and 6 in all these organs. Cheesman (1932) described the androecium as: "consisting of . . . staminodes and . . . fertile stamens, which being the inner whorl, stands opposite the petals." Chatt (1953) and Gnanaratnam (1954) gave no direct commitments regarding the position of the stamen whorl relative to the staminodial whorl. In the materials under report, the androecium is also antepetalous but the stamens compose the outer whorl and not the inner whorl as reported by Cheesman (1932).

Vascular anatomy of the flower. The pedicel is stem-like in structure. The stele is a dictyostele enclosing a pith in the center and delimited by the cortex on the outside. Each sepal receives three traces at the point where the organ is inserted on the receptacle. The median trace remains distinct whereas the lateral traces give off branches so that the sepal has five strands at higher levels. The petals receive three traces. The antepetalous stamens receive double traces which arise at a slightly lower level than those to the antesepalous ones or staminodes. This observation may bear out the report of Cheesman (1932) and Chatt (1953) that the fertile stamens represent morphological pairs which are joined together along the filaments. The staminodes receive single traces. Each carpel has several traces: a prominent dorsal trace resulting from the fusion of smaller ones, numerous laterals on each side of the dorsals, and a single ventral trace. These traces are not prolonged in the style. The ovular traces are products of the coalescence of

branches from the lateral and ventral traces. This observation concurs with that of Puri (1954) on *Cucumis sativus.*

Development of the inflorescence. Cacao is cauliflorous. The inflorescence arises as new primordium from localized cell divisions in the phellogen layer in old stems and in mature portions of lateral branches. A similar mode of initiation has been reported by Juliano (1932) in the development of the inflorescence in *Spondias purpurea.* It is tempting to interpret the inflorescence as "endogenous" in origin in view of the fact that it arises subsuperficially. Thompson (1943-944) interpreted the adventitious buds of the carob tree on similar grounds.

Schimper as cited by Thompson (1933) reported that the flowering shoots of *Couroupita guianensis* arise from axillary buds which have been buried in the bark. Thompson (1953) traced the fate of axillary buds which failed to develop into branches and found that they die in the bark. The flowering shoots of *Couroupita* arise as new bud meristems in nests of cortical cells beneath the bark and not as developmental "continuity" of axillary buds as claimed by Schimper.

There are no indications whatsoever that the inflorescence of cacao arises from vegetative buds.

The inflorescence is constructed on the plan of a cincinus (Bartolome, 1931). The young inflorescence consists of numerous unextended internodes and the flowers are borne on the closely spaced-nodes. This observation upsets the impression that the inflorescence of cacao lacks a central axis.

Sequence of initiation of floral parts. The flowers are formed by bifurcation of the inflorescence axis in dichasial fashion. The development of the floral organs takes place essentially in acropetal succession. The floral bracts are cut off first, followed by the sepals. The petals, stamens, staminodes, and carpels appear next at the same time in the order they are arranged above within the calyx.

Ovule and placentation. The ovule is bitegmic, crassinucellate, and anatropus, as is true among the other members of the family Sterculiaceae investigated by Rao (1949, 1950, 1951).

The placentation of the cacao ovary has consistently been reported in the literature as axile. This is probably the case in the lower one third of the ovary. The margins of the carpels are com-

pletely fused at this level and as a result, the ovary becomes spuriously partitioned into five loculi. The ovary thus appears multilocular with axile placentation. The carpellary margins are, however, free in the upper two thirds of the ovary. The non-fusion of the carpel margins at these levels makes the gynoecium appear unilocular. If one assumes that the septum is formed by the "inward extension of the two placentae themselves and not by the carpellary margins" then the placentation of the ovary is parietal. However, the criterion utilized in the foregoing is not sufficient in itself because it is likely to be modified through secondary alterations, i.e., fusion of the adjacent placental ridges, as was also believed by others on similar grounds.

Puri (1952) contends that anatomical criteria such as the composition of the vascular supply of the placentae, the orientation of the vascular supply of the placentae, and the location of the placentae are more reliable and should be taken into consideration in determining the type of placentation in plants. The axile and parietal types of placentation as defined by him in accordance with the afore-mentioned criteria are presented in table 2. It is clear from

TABLE 2.—*Axile and parietal types of placentation*
[Modified after Puri, 1952]

PARIETAL	AXILE
Placentae borne on fused margins of the same carpel.	Placentae borne on fused margins of different carpels.
Placentae derive their vascular supply from ventrals of the same carpel.	Placentae derive their vascular supply from ventrals of different carpels.
Ventral bundles inversely oriented with reference to the floral axis and lie almost on the same radii as the dorsals.	Ventral bundles normally oriented with reference to the floral axis and lie on different radii from those of the dorsals.

the table that the placentation of the cacao ovary conforms with the definition of Puri for the parietal placentation, except in the orientation of the placental bundles. The placental bundles, unlike the bundles of the usual parietal type of placentation, are inversely oriented relative to the floral axis—"a condition peculiar to the axile type of placentation." This phenomenon has also been reported in the Cruciferae (Gerber, 1900; Hannig, 1901; Eames and Wilson, 1928; Puri, 1941), Papaveraceae (Dickson, 1934; Arber, 1938),

Moringaceae (Puri, 1942),Passifloraceae (Puri, 1945, 1947), Capparidaceae (Puri, 1950), and Cucurbitaceae (Puri, 1954). Puri (1952) interprets the inversion of the placental bundles thus:

> "In the ancestors of these families the ovary had axile placentation—a condition still seen in certain species of the Capparidaceae, Passifloraceae, and Curcurbitaceae. In the change from axile placentation to parietal, the placental strands have shifted to the periphery but they have still retained their inversion so characteristic of the axile placentation. Thus the inversion of these bundles is just a relic of past history which has somehow been retained."

Perhaps it is not unreasonable to adopt this interpretation as a possible explanation for the inverse orientation of the placental bundles in the ovary of cacao.

Megasporangium. The archesporium is subhypodermal in origin and is unicellular. The archesporial cell functions directly as the megaspore mother cell. In *Pterospermum heyneanum, P. acerifolium,* and *P. suberifolium* (Rao, 1949; 1952) the archesporium is also subhypodermal in origin but multicellular. Several archesporial cells function directly as megaspore mother cells. Maheshwari (1950) states that the reported origin of the archesporial cell from the third layer of cells in the nucellus in some plants is probably a misinterpretation caused by the difficulty in distinguishing the archesporial cell at earlier stages of development. Cells occur between the megaspore mother cell and the nucellar epidermis in the megasporangium in cacao. These cells are derived from the nucellar epidermis and not from the archesporial cell. The megaspore mother cell is, therefore, in reality subhypodermal in origin.

Embryo-sac. The development of the embryo-sac has been studied by Kuyjper (1914) as cited by Hakansson (1947). Whether the observation of the present writers conforms or not with that of Kuyjper cannot be determined because of the inaccessibility of the latter's paper. In the material of the writers, the megaspore mother cell gives rise to a linear tetrad of megaspores. The chalazal megaspore functions and the three micropylar ones abort. The functional megaspore divides thrice in succession and gives rise to a normal eight-nucleate embryo-sac as in the *Pterospermum* species (Rao, 1949; 1952) and in *Melochia corchorifolia* (Rao, 1951). In *Pterospermum* species several tetrads function and result in the formation of double and triple embryo sacs in a single ovule. In some cases,

however, only the lowest megaspore in direct contact with the group of nutritive cells functions further, in which case only one embryo-sac is formed.

Starch grains in embryo-sac. Starch grains occur in the mature embryo sac of *Theobroma cacao* (Cheesman, 1927; Cope, 1938; 1939; Hakansson, 1947) and *Pterospermum heyneanum, P. acerifolium, P. suberifolium* (Rao, 1949; 1952) and in the pollen grains of *Melochia corchorifolia* (Rao, 1951). In the present study, starch grains occur in the embryo sac in the functional megaspore cell through the mature embryo sac. The amount of starch grains seem to increase with the stage of development of the embryo-sac and have been observed to be most abundant in the mature ones. The distribution of the starch grains was not pursued beyond the "five-nucleate" stage of the embryo sac. Hakansson (1947) found that the starch grains tend to be more dispersed and diminished in number, 72 hours after fertilization and have often disappeared 96 hours later. The occurrence of starch grains in the embryo-sac of cacao and in other members of the family Sterculiaceae is certainly striking, but it is not, however, peculiar because starch grains have also been reported in other families. Maheshwari (1950) states that the presence of these food reserves in the embryo sacs in the families Aizoaceae, Cactaceae, Portulacaceae, Bruniaceae, Tiliaceae, Crassulaceae, and Asclepiadaceae is a common phenomenon. They have been reported to occur in some members of many unrelated families some of which are Anonaceae, Convolvulaceae, Leguminosae, Xyridaceae, Solanaceae. Liliaceae, Loranthaceae, Saxifragaceae, Gramineae, Phyrmaceae. Rubiaceae, Meliaceae, and Geraniaceae (Dahlgren, 1927; 1939).

Some workers believe that the accumulation of starch grains in the embryo sac, at least in certain plants, is probably associated with the nutrition of the embryo sac. Dahlgren (1927) states that the starch content of the embryo sac reaches its maximum shortly after fertilization and from that time onward it is more or less rapidly consumed. Maheswari (1931) believes that the occurrence of starch in *Albizzia lebbeck* is due to delayed fertilization, as the dissolved food materials diffusing into the embryo sac cannot be utilized and must be temporarily stored. A similar case was observed by Juliano (1934) for the starch grains in the embryo sac of *Sandoricum koetjape.* Hakansson's (1947) observation in *Theobroma cacao* that starch grains in the embryo sac and in nucellular cells adjacent to the egg apparatus tend to disappear shortly after fertilization

and that starch grains remain longer in unfertilized embryo sacs, lends support to the view that the occurrence of starch grains is related to the nutrition of the embryo sac. Maheshwari (1950), however, comments that the possible significance of starch grains and other inclusions in the economy of the embryo sac has not been clarified and substantially proved at present. It may be pointed out at this juncture that the embryo sac of cacao and other species of the family Sterculiaceae so far investigated have certain features in common. They are all characterized by well-developed nucellus, early disappearance of the antipodal cells, persistent synergid cells, late fusion of the polar nuclei, the formation of several endosperm cells before the division of the zygote, and the presence of starch grains.

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MANAGEMENT AND OPERATION OF RICE RETAIL STORES IN LAGUNA, 1958 [1]

DALMACIO A. CRUZ

Thirty-nine of the 50 stores studied were Filipino-owned and operated; the rest were Chinese. Twenty-five of the stores were classified as sari-sari; 14 as general type; and 11 as all-rice retailers. Thirteen rice varieties were sold but only 4 (Wagwag, Macan, Raminad. and Elon-elon) are considered standard varieties.

The retail prices were not associated with either volume of sales or quality of rice retailed. Rice composed 40 per cent of the total sales; canned foods, 21 per cent.

More than one-half of the total sales for Filipino retailers was rice in contrast to only 20 per cent for Chinese retailers. Other food items made up 32 per cent of sales of the Chinese but only 19 per cent of total sales of Filipino retailers.

For all retailers, the value of labor in store operations averaged ₱34 per week. Or this amount, 57 per cent represented the operator's labor; 20.4 per cent, family labor; and 18 per cent, hired labor. The cost of capital consisting mainly of rent, depreciation, interest, and insurance, averaged about ₱13 per week, for all stores. Other costs amounted to ₱9.30 a week for all stores.

The net margin for all stores amounted to ₱90 per week, with a range of ₱18 to ₱252. The retailers that operated business outside the market compounds realized a weekly net margin of ₱136 or three and a half times as much as the net margin of those within the compounds.

Although the costs in store operation were consistently higher for the Chinese than for the Filipino retailers, the gross margins for the former were substantially larger so that they earned relatively larger net margins.

An understanding of the management and operation of food stores shows that a knowledge of retail rice is essential in developing a satisfactory relationship among rice producers, middlemen, and consumers inorder to have an effective marketing program for rice. The producers are interested in obtaining the highest net re-

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turns; the middlemen and retailers, in getting the most for the services they provide.

However, any comprehensive and detailed study of the highly disorganized system for the distribution of milled rice in the country demands not only many years of extensive research, but also considerable cost and the labor of a large number of well-trained research workers. These requisites posed many limitations to the objectives and methods used in this analysis of the rice retail store.

The objectives of the study were to determine: (1) the major characteristics of firms retailing rice; (2) the characteristics of rice sales; (3) sales volumes, costs, prices, and margins in retailing rice in relation to other food items; and (4) to determine the problems connected with retailing rice and offer solutions to the problems.

METHODS

This report covers the first stage of the main study on the economic analysis of rice retailing. The methods used were interview questionnaire technique and uncontrolled observational approach. The former method consisted of personal interviews and complete enumeration of all rice retailers in the four largest retailing centers in Laguna, namely; San Pablo City, Sta. Cruz, Calamba, and Los Baños. This approach provided groundwork for most of the subsequent stages of the study.

Ordinarily, the uncontrolled observational method calls for actual observation of the retailing activities and recording of the quantity of rice purchased, together with prices over a period of time, by the enumerators themselves. In this study, however, the respondents were requested to do these jobs. The study was pursued for a period of 6 months, April through September, 1958.

THE STUDY

General characteristics. Thirty-nine of the 50 stores studied, or 78 per cent of the total, were Filipino-owned and operated. Eleven of the retailers were Chinese general merchants who were mostly retailers of groceries, hardware, and household articles. About three-fourths of all the retailers sold rice in rented stalls or stores in public markets. Those who operated their businesses outside of the market compounds retailed rice mostly in "sari-sari" stores, or what corresponds to "Pa and Ma" stores in the United States. More than

85 per cent of all the retailers did business on cash basis. Only a small proportion of all operators extended credit to customers—due perhaps to the fact that their operating capital was relatively small or to the difficulty of collecting, or both. It was not usual for the retailers to include large quantities of fresh food in their businesses as there were no adequate facilities to handle perishable products.

Location of business. There were major differences between rice retail stores located within public market compounds and those located outside the compounds (table 1). Due to a law which prohibits Chinese nationals from doing business in public markets, all the Chinese retailers were located outside the market compounds. In contrast, all but three of the Filipino-operated stores were located within the compounds. The daily hours of business were practically the same, about 11 hours, for both locations. On Sundays, however, stores within the market compounds were open for business about half an hour longer than those located outside the compounds.

TABLE 1.—*Characteristics of rice retail stores by location of business 50 rice retail stores, Laguna, 1958*

ITEM	LOCATION OF BUSINESS	
	Outside market compounds	Within market compounds
	Total or average	
Number of stores	14	36
Nationality:		
Filipino	3	36
Chinese	11	0
Hours of Operation:		
Week days	11.4	10.9
Sundays	10.4	10.9
Terms of Sales:*		
Cash	85.8	85.6
Credit	14.2	14.4
Type of store:		
Sari-sari	3	22
General merchant	10	4
All-rice retailer	1	10

* Per cent of total sales.

There was no correlation between the place of business and the term of sale. Whether the stores were outside the market compounds or within, the proportion of cash sales, about 86 per cent, was the same. Although there were relatively few retailers located

outside the market compounds, a large proportion of these stores handled practically the same food groups as those carried by the retail stores located within the market compounds. Each of these retail stores had on hand canned and fresh vegetables, meat, cocoa and tea, spices, cigar and cigarettes, baked goods, cereal preparations, and sugar. Very few stores in both locations of business carried full combinations of food items in each specified food group.

Types of store. There were minor differences in the hours of business among the types of retailers (table 2). The sari-sari stores were open for business, both on week days and Sundays, longer than were the general and all-rice merchant. Business on Sundays was about an hour shorter for the general merchants than it was for the other types of stores. The sari-sari store operators most often extended credit to their customers, almost 18 per cent of total sales. In comparison, both the general merchants and all-rice retailers were less liberal in extending credit.

TABLE 2.—*Characteristics of rice retail stores by type of store 50 rice retail stores, Laguna, 1958*

ITEM	TYPE OF STORE		
	Sari-sari	General	All-rice
	Total or average		
Number of store	25	14	11
Hours of operation			
Week days	11.6	11.1	10.9
Sundays	11.1	10.2	10.9
Term of Sales *			
Cash	82.2	86.1	87.0
Credit	17.8	13.9	13.0

* Per cent of total sales.

CHARACTERISTICS OF RICE SALES

The most common unit of sale for rice was one to three gantas. Occasionally, the retailers sold large quantities that ranged from one-half to two cavans. For computation and simplification purposes, cavan sales were reduced to ganta units. The sale price per cavan was divided by 25 to calculate the price per ganta. All ganta sales were then added together and divided by 25 in order to determine the weekly sales in cavans.

Varieties. Thirteen rice varieties were reported sold in the stores during the period of study. Most of them were recognized

standard varieties while others were arbitrarily established by the retailers themselves or by wholesalers who supplied the rice. The non-standard varieties were usually a mixture of less popular varieties of rice. Purity of variety, cleanliness, and general milling quality were the usual criteria for classifying rice.

The standard varieties included Wagwag, Macan, Raminad, and Elon-elon. Wagwag and Macan were retailed under three classes each. They were the most important varieties handled in terms of sales and gross margins (table 3). Of the average weekly sales of 23.4 cavans for all stores, Wagwag accounted for 8.3 cavans or about 35 per cent of the total. As a result, class 1 Wagwag returned the highest gross margin, ₱3.97 per week, but ranked second in volume and sales. For the same variety, class 2 had about the same sales volume as class 1 but contributed only ₱1.34 to gross margin.

TABLE 3.—*Average weekly rice sales by variety 50 rice retail stores, Laguna, 1958*

VARIETY OR CLASS	CAVANS SOLD	WHOLESALE COST	RETAIL VALUE	GROSS MARGIN
		pesos	*pesos*	*pesos*
Wagwag:				
Class 1	3.8	105.55	109.52	3.97
Class 2	3.6	96.02	97.36	1.34
Class 3	0.9	23.00	23.15	0.15
Macan:				
Class 1	2.4	60.88	63.29	2.41
Class 2	4.1	101.43	104.61	3.18
Class 3	0.7	17.77	17.91	0.14
Raminad	1.6	42.28	44.31	2.03
Quezon	2.5	66.84	68.34	1.50
12 × 36	1.3	36.48	38.14	1.66
Elon-elon	0.6	16.60	17.24	0.64
Malagkit	0.4	11.38	11.68	0.30
Others	1.5	39.44	40.99	1.55
Total	23.4	617.67	636.54	18.87

Class 2 Macan had the largest sales, 4.1 cavans and was second in importance in gross margin. On the basis of wholesale cost per cavan, Macan classes 1 and 2 averaged about the same.

Malagkit had the highest unit cost, lowest volume of sales, and contributed only ₱0.30 on the average to gross margin. This class of rice comes in numerous glutinous varieties and is used mainly

for making rice cakes, "pinipig", and several delicacy preparations. As such, Malagkit is not widely purchased as staple grain.

Raminad, Quezon, "12 × 36", and Elon-elon ordinarily compared favorably in price and quality with first class Wag-wag, but cost more than Wagwag classes 1 and 2 and all Macan classes. Their combined sales were even lower than the volume of sales for the three classes of Macan.

Retail prices. During the survey, the retail prices of rice averaged ₱1.18 a ganta for all varieties (table 4). The price of rice per ganta ranged from ₱1.10 for class 3 Wagwag and Macan to ₱1.42 for Malagkit.

TABLE 4.—*Retail prices and sales of rice by variety 50 rice retail stores, Laguna, 1958*

VARIETY OR CLASS	AVERAGE CAVANS SOLD PER WEEK	AVERAGE RETAIL PRICE PER GANTA
		pesos
Wagwag:		
Class 1	3.8	1.24
Class 2	3.6	1.16
Class 3	0.9	1.10
Macan:		
Class 1	2.4	1.14
Class 2	4.1	1.12
Class 3	0.7	1.10
Raminad	1.6	1.14
Quezon	2.5	1.12
12 × 36	1.3	1.20
Elon-elon	0.6	1.26
Malagkit	0.4	1.42
Others	1.5	1.15
All varieties or classes	1.4	1.18

There was no definite relationship of price to either volume of sales or quality of rice retailed. With the exception of Elon-elon, the lowest priced varieties or classes of rice did not necessarily sell the most and vice-versa. On the average, class 2 Macan sold more than four cavans a week at a price of ₱1.12 per ganta. In contrast, Macan class 3 which was retailed, on the average, at 2 centavos lower than class 2, sold less than a cavan each week. In the same manner, class 1 Wagwag had an average sales of almost four cavans a week

even at a retail price of 14 centavos higher per ganta than class 3 Wagwag. Class 3 Wagwag sold only 0.9 cavans a week.

It would seem, therefore, that consumers had their preference for class or variety of rice without much regard to price differences.

Weekly Sales and Gross Margins

In general, retailing rice was not the only source of income for most of the store operators. Where rice was the main item handled, the retail business was typically a minor source of income. In this case, it was usually the wife or daughter that tended the store while the husband was engaged in some other occupation. Similarly, most of the operators of sari-sari stores derived income from other sources. Otherwise, the unstable and meager earnings from selling rice or from sari-sari retail businesses were hardly adequate to support the operator's family. On the other hand, merchandising was the major if not the only source of income, for the general merchants.

As a weekly average for all stores, retail sales amounted to ₱1653 (table 5). Rice was the most important item with sales of about ₱637 or almost 40 per cent of the total sales. Sales of all canned foods amounted to ₱343 or about 21 per cent of all sales. Baked goods, fresh meat, eggs and poultry, and cereal preparations were next in order of importance.

TABLE 5.—*Average weekly food sales and gross margins 50 rice retail stores, Laguna, 1958*

PRODUCT GROUP	RETAIL SALES	PROPORTION OF TOTAL SALES	MARKUP	WHOLESALE COSTS	GROSS MARGIN
	pesos	*per cent*	*per cent*	*pesos*	*pesos*
Rice	636.54	38.5	3.1	617.67	18.87
All canned foods	343.14	20.8	14.9	298.53	44.61
Fresh meat, eggs, and poultry	72.21	4.4	16.3	62.10	10.11
Baked goods	101.33	6.1	9.9	92.21	9.12
Cereal preparations	41.95	2.5	16.3	36.08	5.87
Fresh fruits and vegetables	19.51	1.2	12.4	17.36	2.15
Fresh fish	18.39	1.1	12.3	16.37	2.02
Other food items	420.28	25.4	14.9	365.64	54.64
Total or average	1653.35	100.0	9.8	1505.96	147.39

The average markup for all products was 9.8 per cent . The markups ranged from 3.1 per cent for rice to 16.3 per cent for

fresh meat, eggs and poultry, and cereal preparations. Incidentally, the period of study coincided with the NARIC's importation of several thousand tons of rice in an attempt to offset the impending rice shortage and rising prices. This development forced the retailers to dispose of their current stock, sometimes even at a loss. Before the rice importation program, rice normally had an average markup of about 8 per cent as shown in an earlier study of retail stores in the same province. If the markup on rice were considered as 8 per cent,[2] the average markup for all sales would have been nearly 12 per cent (11.8 per cent).

Considering gross margins, *other items,* (representing a wide variety of products including soft drinks and tobacco), were most important. Next in importance as source of gross margin was canned foods. This group consisted largely of sardines, salmon, corned beef, and potted meat. Rice, due to the unusually low markup, was third in importance as a contributor to gross margin even though sales were larger than for any other product group. Fresh meat, eggs and poultry, and cereal preparations which had the largest percentage markup contributed only a small amount to margins. Based on markups, these two food groups proved to be the most profitable items but for the fact that prices were relatively high and not within the reach of the typical consumer. Consequently, these items were not sold regularly or sold only in relatively small quantities. Cereal preparations which included macaroni, spaghetti, "bihon", "misua", and "sotanghon" were sold as a rule only during fiestas and special occasions. Baked goods, fish, fruits and vegetables generally were sold by specialized retailers; hence, they added but little to the gross margin in spite of the relatively favorable markups.

Nationality. Most of the sari-sari store operators and all-rice retailers were Filipinos. Rice was the most important food item they retailed composing more than one-half of their total sales (table 6). However, as measured by average weekly gross margin, rice ranked second in importance. Other food items constituted only about 19 per cent of total sales but returned the most in gross margin. This difference was largely influenced by the gap of about 12 points between the markups for rice and this group.

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[2] Quintana, E. *In* L. B. Darrah, "Marketing Farm Products in the Philippines," Department of Agricultural Economics, College of Agriculture, University of the Philippines, July, 1958.

TABLE 6.—*Average weekly food sales and gross margins of stores operated by Filipinos*
50 rice retail stores, Laguna, 1958

PRODUCT GROUP	RETAIL SALES	PROPORTION OF TOTAL SALES	MARKUP	WHOLESALE COSTS	GROSS MARGIN
	pesos	*per cent*	*per cent*	*pesos*	*pesos*
Rice	614.75	55.3	2.5	599.98	14.77
All canned foods	130.85	11.8	14.9	113.85	17.01
Fresh meat, eggs and poultry	71.97	6.4	16.3	61.89	10.08
Baked goods	23.06	2.2	9.9	20.98	2.08
Cereal preparations	13.32	1.2	16.2	11.46	1.86
Fresh fruits and vegetables	21.51	1.9	12.4	19.14	2.37
Fresh fish	22.78	2.1	12.4	20.27	2.51
Other food items	212.42	19.1	14.9	184.80	27.62
Total or average	1110.67	100.0	7.6	1032.37	78.30

Canned foods, fresh meat, eggs and poultry represented about 18 per cent of the total sales. Sales for these products almost equaled the gross margin for the other food items. As in most of the stores, baked goods, cereal preparations, and fish represented minor items in the merchandise.

Unlike the Filipino-operated stores, the weekly food sales for the Chinese stores were not heavily concentrated on one particular food item. Other food items were the most important group of merchandise and accounted for a third of the total sales (table 7).

TABLE 7.—*Average weekly food sales and gross margins of stores operated by Chinese*
11 rice retail stores, Laguna, 1958

PRODUCT GROUP	RETAIL SALES	PROPORTION OF TOTAL SALES	MARKUP	WHOLESALE COSTS	GROSS MARGIN
	pesos	*per cent*	*per cent*	*pesos*	*pesos*
Rice	695.59	19.5	3.4	672.91	22.68
All canned foods	1077.68	30.2	14.9	937.58	140.10
Cereal preparations	143.56	4.1	16.3	123.46	20.10
Baked goods	378.82	10.6	9.9	344.73	34.09
Fresh fruits and vegetables	73.04	2.0	12.4	65.01	8.03
Fresh fish	2.78	0.1	12.6	2.47	0.31
Fresh meat, eggs, and poultry	44.51	1.2	16.3	38.28	6.23
Other food items	1157.21	32.3	14.9	1006.77	150.44
Total or average	3573.19	100.0	12.2	3191.21	381.98

On the average, this food group returned a weekly gross margin of ₱150. Rice made up 20 per cent and canned foods 30 per cent of the total sales but the gross margin for rice was only ₱38 in contrast to ₱140 for canned foods.

It should be noted that 10 of the 11 Chinese operators were general merchants. Therefore, an analysis by nationality is essentially the same as that for type of business operated.

Location of business. The total weekly sales of stores operating within the public market compounds amounted to ₱1121 (table 8). The markup for these stores amounted to 7.6 per cent and the gross margin, ₱79 weekly. These stores were primarily sari-sari and all-rice stores operated by Filipinos.

TABLE 8.—*Average weekly food sales and gross margins of stores located in market compounds*
36 rice retail stores, Laguna, 1958

PRODUCT GROUP	RETAIL SALES	PROPORTION OF TOTAL SALES	MARKUP	WHOLESALE COSTS	GROSS MARGIN
	pesos	*per cent*	*per cent*	*pesos*	*pesos*
Rice	630.80	56.2	2.6	614.80	16.00
All canned foods	131.10	11.8	14.9	113.98	17.03
Fresh meat, eggs and poultry	70.46	6.3	16.3	60.60	9.86
Baked goods	16.42	1.5	9.9	14.94	1.48
Cereal preparations	12.63	1.1	16.3	10.86	1.77
Fresh fruit and vegetables	18.13	1.6	12.3	16.14	1.99
Fresh fish	21.61	1.9	12.4	19.23	2.38
Other food items	220.23	19.6	14.9	191.60	28.63
Total or average	1121.29	100.0	7.6	1042.15	79.14

Rice constituted the most important food item sold by the retailers that operated their businesses within the compounds of the public markets. Fifty-seven per cent of the total retail sales of these stores was rice. But due to the low markup of 2.6 per cent for rice sold by these groups of stores, the gross margin for all retailers averaged only ₱16 a week. Canned foods which represented only 12 per cent of the total sales provided slightly more margin than rice each week. Similarly, eggs returned nearly ₱10 of gross margin although its share of the total sales was less, only six per cent.

Unlike the retailers located within the market compounds, those operating their businesses outside the compounds had relatively high

sales, markups, and margins for all products (table 9). Sales averaged ₱2209 per week. The average markup was 10.8 per cent. As a result, the gross operating margins amounted to about ₱216 per store. Rice and all other food items comprised the most important groups of items and represented almost three-fourths of the total sales. As measured by gross margins, however, the other food item group provided almost 5 times more margin than did rice.

TABLE 9.—*Average weekly food sales and gross margins of stores outside market compounds*
14 rice retail stores, Laguna, 1958

PRODUCT GROUP	RETAIL SALES	PROPORTION OF TOTAL SALES	MARKUP	WHOLESALE COSTS	GROSS MARGIN
	pesos	*per cent*	*per cent*	*pesos*	*pesos*
Rice	651.65	29.4	4.0	626.48	25.17
All canned foods	85.03	3.8	14.9	73.98	11.05
Fresh meat, eggs and poultry	74.23	3.3	16.3	63.84	10.39
Baked goods	319.66	14.5	9.9	290.89	28.77
Cereal preparations	117.34	5.3	16.3	100.91	16.43
Fresh fruits and vegetables	15.85	0.7	12.3	14.11	1.74
Fresh fish	10.08	0.5	12.4	8.97	1.11
Other food items	934.87	42.5	14.9	813.34	121.53
Total or average	2208.71	100.0	10.8	1922.52	216.19

Baked goods had the third largest total sales and margins in spite of its relatively small proportion, 14.5 per cent, of total sales. Cereal preparations accounted for less than 3 per cent of total sales but had a gross margin of about half as large as that for rice. Fish, fruits, and vegetables were minor items of merchandise.

COSTS OF STORE OPERATION

At the time of the survey, it was not customary for the storeowners to consider rice retailing, particularly, as a business proposition. As such, the retailers invariably kept no records of the business except for casual lists of the quantity and unit costs of rice purchased, light and water bills, and license or tax payment invoices. The rice purchase list, usually kept for only short periods of time, was used as the basis for determining markups. Due to the absence

of business records, labor costs in store operations, except for cash payments for hired labor, represented imputed costs.

Labor. Practically all of the operators based their estimates of the cash value of their time and labor on the existing monthly wage rates of the average office worker. Family labor, which consisted of on-and-off services of household members, was evaluated on the basis of prevailing monthly wages of hired workers. Hired labor, on the other hand, was made up mainly of "cargadores" fees. Large stores, however, maintained more or less temporary laborers. From these estimates, the weekly equivalent value of labor was calculated.

For all retailers, the value of labor in store operations averaged ₱34 per week (table 10). Of this amount, 57 per cent or about ₱20 represented the operator's labor; 25 per cent, family labor; and 18 per cent, hired labor. In terms of time spent in store operations, the labor for all stores averaged an equivalent of 22.5 months on the basis of an 8-hour day. The operator's labor accounted for 14.8 months equivalent and the combined family and hired labor about half as much.

TABLE 10.—*Labor costs in retail store operation 50 rice retail stores, Laguna, 1958*

ITEM	MONTHS EQUIVALENT PER YEAR	VALUE PER WEEK
		pesos
Operator's labor	14.8	19.52
Family labor	4.6	8.51
Hired labor	3.1	6.23
Total	22.5	34.26

The Chinese retailers spent somewhat more time in operating their stores and incurred sharply higher labor costs than did the Filipino operators. As an average, the weekly value of labor for the Chinese storeowners was about ₱54 and the month equivalent per year of the labor force was 24.6 months in contrast to about ₱31 and 21.9 months for the Filipino retailers (table 11). The relatively high costs of labor for the Chinese-operated stores was more the result of a high value placed on their time rather than the amount of time worked. The weekly value of the family labor of

the Filipino retailers, ₱7, was about half the value of the Chinese family labor although the latter had less than a month additional time. Considerably more hired labor at a slightly higher rate of pay was utilized by the Chinese and consequently higher costs incurred than for the Filipino operators.

TABLE 11.—*Labor costs in store operation by nationality of retailers 50 rice retail stores, Laguna, 1958*

ITEM	FILIPINO		CHINESE	
	Months equivalent per year	Value per week	Months equivalent per year	Value per week
		pesos		*pesos*
Operator's labor	14.7	16.86	15.1	27.27
Family labor	4.4	7.01	5.1	13.55
Hired labor	2.8	6.92	4.4	13.01
Total	21.9	30.79	24.6	53.83

Capital. The costs of capital in store operations consisted mainly of rent for the store or market stall, or depreciation, interest, repairs, and insurance on owned store space and equipment, and interest and insurance on goods on hand. Since almost all the retailers handled both food and non-food items in the business, only the proportion properly used by the food store was considered in computing the average weekly cost for each item. For all retailers, the capital cost averaged about ₱13 per week (table 12).

All but four of the operators rented the store space or market stall in which they operated their businesses. As an average, the weekly rent amounted to ₱7.83. The average value of the four owned store spaces was ₱411 but the interest rate of 6 per cent and depreciation charge of 5 per cent per year averaged only about ₱0.90 each week. All the store operators owned the equipment they used. The value of the equipment averaged ₱364 and cost a total of ₱1.08 each week for interest and depreciation. The equipment included sales cases, cash register, safe, desk, chairs, shelvings, scale, ganta, and the like. The saleable items were valued at ₱2187 and consisted of available stock while other items were valued at ₱87 and represented bags, sacks, and binding materials. The capital cost for stock averaged ₱3.67 per week. Only eight retailers reported having insurance for their supplies.

TABLE 12.—*Capital costs in store operation 50 rice retail stores, Laguna, 1958*

COST ITEM	RENTED SPACE 46 stores		OWNED SPACE 4 stores		ALL STORES	
	Average value	Weekly cost	Average value	Weekly cost	Average value	Weekly cost
			pesos			
Buildings			411			
Rent		7.83				7.20
Interest at 6%		—		0.49		0.40
Depreciation at 5%		—		0.41		0.33
Repairs		—		—		—
Equipment	388		177		364	
Interest at 6%		0.44		0.21		0.41
Depreciation at 10%		0.74		0.35		0.67
Repairs		—		—		—
Stocks						
Saleable items	2307		934		2187	
Other items	90		54		87	
Total	2397		988		2274	
Interest at 6%		2.76		1.15		2.63
Insurance		1.12		0.17		1.04
Total	2780	12.89	1576	2.78	2638	12.68

The average cost of capital for the Chinese-operated retail stores amounted to ₱32 per week (table 13). This was nearly six times the capital cost for retail stores operated by Filipinos. As an average, the interest and depreciation costs for stores owned by Filipino retailers amounted to ₱1.12 a week in comparison with an average weekly rent of ₱3.59 for those who rented stores. On the other hand, one Chinese owner-operated store had only 19 centavos per week for interest and depreciation charges in contrast to ₱21 for the Chinese who rented the store spaces they used for the business. The latter comparison, however, is of little significance since the one Chinese store that was owned was small in contrast to the 10 rented stores operated by Chinese. The latter stores were located in business centers while the former store was out of the business section.

The average value of equipment for all the Filipino-operated stores was ₱229 and interest and depreciation charges an equipment amounted to ₱0.71 per week. The Chinese stores had ₱1011 for value of equipment which averaged ₱3.27 per week for interest and depreciation costs. In terms of average value of stocks, the Chinese stores had stock valued at ₱6544 which was almost five times the value of

stock for Filipino-operated stores. As an average, the weekly cost of stocks in the Chinese stores was ₱10.11 compared to ₱1.70 for the Filipino stores.

TABLE 13.—*Capital costs in store operation by nationality 50 rice retail stores, Laguna, 1958*

COST ITEM	RENTED STORE SPACE			OWNED STORE SPACE			ALL STORES
	Stores reporting	Average value	Weekly cost	Stores reporting	Average value	Weekly cost	Average weekly cost
		pesos			*pesos*		
Operated by Filipinos							
Buildings	36	—	3.59	3	394	1.12	3.40
Equipment	36	232	0.72	3	195	0.60	0.71
Stocks	36	1387	1.73	3	1041	1.26	1.70
Total		1619	6.04		1630	2.98	5.81
Operated by Chinese							
Buildings	10	—	21.00	1	90	0.19	19.11
Equipment	10	1107	3.41	1	60	0.19	3.27
Stocks	10	7121	10.22	1	780	0.90	10.11
Total		8228	34.63		890	1.28	32.49

Other costs. In addition to labor and capital costs involved in store operation, there were a number of other costs that call for a separate analysis as presented in table 14. For all stores, these costs amounted to ₱9.30 a week. Wrappers, including such materials as waxed paper, paper bags, aluminum foil, old newspapers, and gen-

TABLE 14.—*Miscellaneous costs in store Operation 50 rice retail stores, Laguna, 1958*

COST ITEM	AVERAGE WEEKLY COST
	pesos
Taxes and licenses	1.30
Wrappers	3.46
Containers	0.88
Electricity	0.66
Contributions	0.65
Water	0.02
Other	2.33
Total	9.30

eral-purpose brown wrapping paper, accounted for almost a third of the total. Taxes and licenses averaged ₱1.30 a week for all retailers and ranked as the second most important cost item. Containers, electricity, and contributions averaged ₱2.19 a week. Cost of water was negligible since the retailers had very little use for water; besides that, use of water facilities was generally inexpensive.

Net margin. The net margin is the difference between the gross margin and the costs involved in store operation. This represents also the net profit in the retail food business. For all stores, the net margin amounted to about ₱90 per week (table 15). As expected, the most efficient group of stores and consequently those with the highest net margin, ₱252, were the large stores. In comparison, the small and medium-sized stores realized only ₱18 and ₱42 per week, respectively.

TABLE 15.—*Weekly net margin in store operation by size of business 50 rice retail stores, Laguna, 1958*

ITEM	SIZE OF BUSINESS			ALL STORES
	Small	Medium	Large	
Number of stores	18	18	14	50
			pesos	
Sales	772.10	1089.51	3416.23	1653.35
Gross	51.84	86.63	341.39	147.39
Costs:				
Labor	24.76	31.65	49.60	34.26
Capital	4.24	6.55	24.88	12.68
Miscellaneous	5.09	6.57	15.39	9.30
Net margin	17.75	41.86	251.52	89.55

The wide variation in net margin between the medium and small stores on the one hand, and the large stores on the other, is the result of an equally wide variation in sales and gross margins between these groups of stores. There was less variation in the costs than there was in gross margins. Whereas the total costs for small, medium, and large stores were ₱37, ₱53, and ₱99, respectively, the gross margin for large stores in contrast was more than 6 times and 4 times larger, respectively, than the gross margin for the small and medium stores.

The retailers that operated businesses outside the market compounds realized a net margin of ₱136 per week. This amount was three and a half times larger than the weekly net margin for the retailers located within the compounds (table 16). Cost items were invariably larger, about twice as large, for the stores outside than for those within the market compounds. However, the gross margin for stores located within the compounds was only ₱97 compared to ₱216 for those outside the public market.

TABLE 16.—*Weekly net margin in store operation by location of business*
50 rice retail stores, Laguna, 1958

ITEM	OUTSIDE MARKET COMPOUNDS	WITHIN MARKET COMPOUNDS
Number of stores	14	36
	pesos	
Gross margin	216.19	79.14
Costs:		
Labor	49.21	28.32
Capital	18.62	5.80
Miscellaneous	12.28	7.33
Net margin	136.08	37.69

By type of business, the all-rice retailers just about broke even in the rice retail trade. They realized only a very small net margin of about ₱5 a week in contrast to ₱268 for the general merchants (table 17). This would indicate that the store operators handling

TABLE 17.—*Weekly net margin in store operation by type of business*
50 rice retail stores, Laguna, 1958

ITEM	SARI-SARI STORES	ALL-RICE RETAILERS	GENERAL MERCHANTS
Number of stores	25	11	11
		pesos	
Gross margin	83.76	40.52	359.35
Costs:			
Labor	30.14	22.84	49.78
Capital	5.64	4.84	28.41
Miscellaneous	7.06	8.00	13.41
Net margin	40.92	4.80	268.02

rice mainly earned prevailing wages for their efforts. It also suggests that food items other than rice provide the profit for retailers.

The variation in costs among groups of stores was much smaller than the variation in gross margins. Gross margins ranged from ₱41 for all-rice retailers to ₱359 for general merchants but the range in labor cost, for example, was from only ₱23 to ₱97 for the same types of business.

Although the costs in store operation were consistently higher for the Chinese than the Filipino retailers, the gross margins for the former retailers were substantially larger so that they earned relatively large net margins (table 18). The Chinese netted ₱283 to only ₱35 for the Filipino retailers.

TABLE 18.—*Weekly net margin in store operation by nationality of retailers*
50 rice retail stores, Laguna, 1958

ITEM	FILIPINO	CHINESE
Number of stores	39	11
	pesos	
Gross margin	78.30	381.98
Costs:		
Labor	30.79	53.83
Capital	5.80	31.59
Miscellaneous	7.11	13.13
Net margin	34.60	283.43

CONCLUSION

The rice retailers were mostly marginal, small-store operators. They should strive to increase the size of their business through better merchandising or the addition of other products to attain retailing efficiency. This would permit more effective utilization of the available labor supply. Although the cost of store operation is generally low, which encourages many people to enter the business, there is opportunity for vast improvement in practices and returns.

The Filipino retailers have much to learn from the Chinese store operators with reference to handling the retail trade for profit. The large volume of business that the Chinese storekeepers handled ac-

counted mainly for their success in the retail industry. Furthermore, the majority of the Filipino-operated stores were concentrated in the market compounds where competition is usually keen. These operators should consider the alternative of changing the location of their business since those that operated businesses outside the compounds were better off in terms of sales and net margins.

GERARDO O. OCFEMIA *

WHEREAS, the U.P. College of Agriculture, the agricultural profession, and the country lost an internationally renowned scientist, a beloved teacher, a devoted husband and father, and a gentleman in the death of Dr. Gerardo Offemaria Ocfemia; and

WHEREAS, his outstanding conntributions to the field of plant pathology, notably those on the bunchy-top and mosaic of abaca, Fiji disease and mosaic of sugar cane, and cadang-cadang of coconut, have earned for him the title of dean of Filipino plant pathologists; and

WHEREAS, from the time he joined the University to his appointment as Professor Emeritus, he distinguished himself as a representative of the Philippines to both national and international conferences and as a contributor to foreign and local journals; and

WHEREAS, as teacher and researcher, he fostered science-consciousness in agriculture; now therefore be it

RESOLVED, that the faculty of the College of Agriculture of the University of the Philippines, hereby express its feeling of grievous loss and extend to his widow and children its deepest sympathy; and be it further

RESOLVED, that this resolution be recorded in the minutes of the faculty of the College of Agriculture and copies sent to the archives of the University, and that it be published in *The Philippine Agriculturist.*

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* Resolution passed by the faculty of the College of Agriculture on March 5, 1960.

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